

# METAL

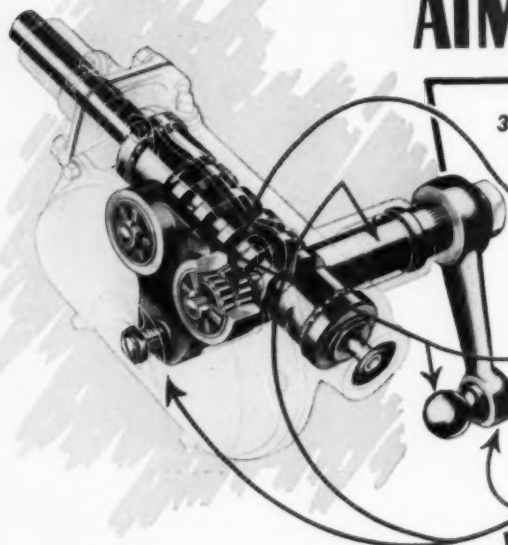
*PROGRESS*



OCTOBER 1951

# There's Long, Hard Wear in STEERING GEARS

## ...PUT THERE BY 'SURFACE' <sup>RX</sup> PREPARED ATMOSPHERES



### 3 Controlled Atmospheres for Heat Treating

Work flow in the plant producing this steering gear is arranged around 3 controlled atmosphere processes: carburizing, dry cyaniding, clean hardening.

● **Carburizing:** Steering gear cams, the "heart" of the assembly, are carburized in 4 'Surface' pit type radiant tube furnaces each with an enriched RX controlled atmosphere. Each furnace handles about 1500 lbs. net. Minimum hardenable case depth of 0.040-in.

● **Dry Cyaniding:** Studs and balls subject to frictional wear and impact stress in final assembly are given optimum physical properties by a dry cyaniding treatment with a 'Surface' RX atmosphere enriched with natural gas and ammonia. Studs are cyanided to case depth of 0.008-in. Balls are treated to case depth of 0.010-0.015-in. Heat treatments are accomplished in a continuous articulated link belt furnace.

● **Clean Hardening:** Lever shafts and steering arms are first isothermally annealed, then clean hardened in a 'Surface' rotary hearth furnace with radiant tubes and an RX controlled protective atmosphere.

*Ever hear of an auto accident due to steering gear going bad? Quite likely you never will, because right before your eyes is proof that steering mechanisms (other parts and products, too) are made safe and dependable.*

All vital and moving parts of the steering assembly shown above undergo one or more controlled atmosphere heat treatments: carburizing, cyaniding, clean hardening, where results are uniform and consistently within close tolerances.

These controlled atmosphere heat treatments are carried out in radiant tube-fired furnaces of types best suited for handling the particular parts. The furnace types include pit, rotary hearth and continuous articulated link belt types.

#### RX PREPARED ATMOSPHERES

Atmospheres for these 3 distinctly different heat treat processes are prepared in 2 centrally located 'Surface' RX generators manifolded the RX carrier gas for all atmosphere requirements. Saves money, saves space!

'Surface' RX generators for making prepared atmospheres are employed successfully in hundreds of plants for many processes: carburizing, clean hardening, bright annealing, carbon restoration, homogeneous carburizing and dry cyaniding.

'Surface' is a pioneer in prepared atmosphere equipment, furnishing not only RX, but also DX, NX, HX, HNX, AX and Char-Mo gas atmospheres. Send for Bulletin SC-155 on prepared atmospheres. Write today on your letterhead.

**'Surface'**  
**INDUSTRIAL**  
**FURNACES**

**SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO**





## HOW SURFACE COMBUSTION HELPS CUT CARBURIZING COSTS

### *with rotary retorts cast in Thermalloy\**

A main part of the inside story of this Surface Combustion continuous carburizing furnace is the rotary retort we cast for it. Developed and built by Surface Combustion Corporation, these furnaces with Thermalloy retorts are operating successfully in a number of roller bearing and automotive parts plants.

To make sure small parts pass through the spiral cycle and are discharged at exactly the right time, the passage must be free from obstructions. No part can be allowed to "hang up" and carburize too deeply, since individual inspection of parts is impractical. Thanks to careful

foundry practice and a unique method of cleaning castings internally, these 16' retorts operate precisely as designed.

For retorts, furnace parts, trays, racks, pots, muffles—Thermalloy gives you more operating hours per dollar. Whatever your heat-and-abrasion-resistance problem, our engineers will help you select the right grade of Thermalloy, engineer the casting and foundry practices necessary to produce it for lowest cost service life. On your next problem, why not call in an Electro-Alloys engineer? Write Electro-Alloys Division, 2091 Taylor Street, Elyria, Ohio.



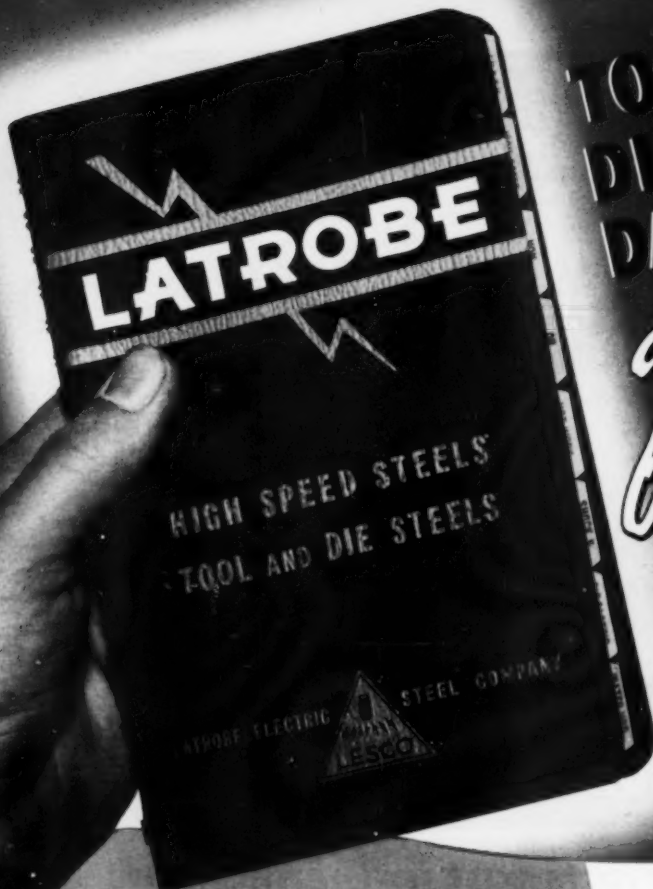
\*Reg. U. S. Pat. Off.

AMERICAN

**Brake Shoe**

COMPANY

**ELECTRO-ALLOYS DIVISION**  
ELYRIA, OHIO



TOOL AND  
DIE STEEL  
DATA...

*at your  
fingertips*

- ★ ANALYSES AND PROPERTIES
- ★ RECOMMENDED HEAT TREATING
- ★ FORMS IN WHICH FURNISHED
- ★ TYPICAL APPLICATIONS

PUBLISHED AS ANOTHER LATROBE SERVICE TO TOOL AND DIE STEEL USERS... SHOPMEN, TOOL AND DIE MAKERS, FOREIGN ENGINEERS... THIS HANDY, POCKET-SIZE REFERENCE BOOK GIVES YOU UP-TO-THE-MINUTE INFORMATION ON EACH OF THIRTY-FIVE OF THE MOST WIDELY KNOWN AND USED TYPES OF TOOL AND DIE STEELS PRODUCED BY LATROBE ELECTRIC STEEL COMPANY.

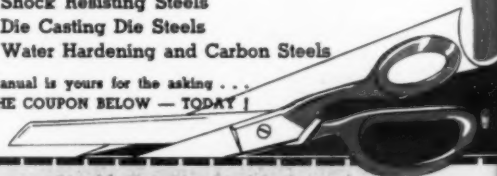
Eighty-six pages, 4" x 7", bound in a flexible cover, this manual is designed to fit your pocket. Reverse sides of index tabs show tables and data of practical value in everyday practice:

- ★ Decimal equivalents of one inch
- ★ Hardness, temperature and millimeter conversion tables
- ★ Weights, by size, of hot rolled round bars, drill rod, flat and square bars.

Handy index tabs for easy selection of:

- ★ High Speed Steels
- ★ Non-deforming Die Steels
- ★ Oil Hardening Die Steels
- ★ Hot Work Steels
- ★ Shock Resisting Steels
- ★ Die Casting Die Steels
- ★ Water Hardening and Carbon Steels

This manual is yours for the asking...  
USE THE COUPON BELOW — TODAY!



**LATROBE ELECTRIC  
STEEL COMPANY**  
LATROBE, PENNSYLVANIA

SOLE PRODUCERS OF DESIGNATED BRAND STEELS

Branch Offices & Warehouses: BOSTON, BUFFALO, CHICAGO, CLEVELAND, DAYTON, DETROIT, HARTFORD, LOS ANGELES, MILWAUKEE, NEW YORK, PHILADELPHIA, PITTSBURGH, SEATTLE, TOLEDO

Sole Agents: BIRMINGHAM, DALLAS, DENVER, HOUSTON, ST. LOUIS, WICHITA

LATROBE ELECTRIC STEEL COMPANY, Latrobe, Pa.

Gentlemen: Please send me, at once, your tool and die steel manual at no obligation. MP2

NAME .....

TITLE .....

COMPANY .....

STREET .....

CITY ..... ZONE ..... STATE .....

# Here's what metal working management will want to know about Microcarb Control

**N**OTHING else can do what Microcarb does in controlling the carburization of steel parts. Gears, shafts, cams, bearings and all the other items which owe some of their high quality and low cost to the carburizing process can now be made even better—and possibly at even lower cost.

The cause of such improvement is simply that Microcarb measures directly the carburizing "strength" of the furnace gases which supply carbon to the work being processed.

Heretofore many carburizing equipments have measured the amount of carbonaceous material fed into the furnace, but none has **directly** measured the active carbon in the hot furnace gas. For a comparison, think of heating your home by putting fuel in the furnace, without a thermometer to tell the temperature. Keeping your home at the same temperature day in and day out would then be an art rather than a science; some one person's judgment would have to be accepted, but there'd be no check. The comparable condition has heretofore been quite common in carburizing operations, everywhere.

Microcarb ends that uncertainty; it measures and controls carbon directly. Heat-treaters simply set the Microcarb Controller at 90 if they wish to carburize to ninety carbon. "The carbon you set is the carbon you get".

The "reason why" for Microcarb is its carbon de-

tecting element. This invention, called a Carbohm, is an engineering rarity—a truly new device for sensing a change in its surroundings.

Basically, a Carbohm is a wire, made of an alloy which will either absorb carbon from the furnace atmosphere, or lose it to the atmosphere, until it and the atmosphere are in equilibrium, carbon-wise.

With every change in the wire's carbon content, there's a corresponding change in its electrical resistance. The two Microcarb instruments—Controller and Carbon Recorder—translate this resistance directly into terms of percent carbon, control on that basis and record the result.

**Only Homocarb carburizing equipment** of our new Series H can be used with Microcarb, because the furnace and its temperature control must be designed to meet the needs of atmosphere regulation. Specific features are a soundly designed electric furnace with solid-bottom retort, improved fan housing and work support, and aerodynamically designed discharge jets. Micromax temperature control of the Duration-Adjusting Type is included.

## Microcarb is many things to many men, especially in defense work.

**To top management**, Microcarb means better competitive position (for the individual company) quality-wise and possibly cost-wise. Also, it meets the usual desire for process control which is fully automatic.


**To production executives**, Microcarb means closer following of production schedules, because carburizing speeds and results are definitely more predictable than ever before.

**To personnel executives**, Microcarb means cleaner, more attractive working conditions. And, if the heat-treat uses incentive pay, Microcarb helps heat-treaters increase their earnings, because it makes

it easier for them to apply their skill and therefore increase their productivity.

**To metallurgists**, Microcarb means some or all of the above advantages, plus a tightening of technique such as every technician likes. "New" or hard-to-handle steels hold fewer puzzles. Standard steels emerge with closer specifications. The heat-treat takes another long step toward becoming a manufacturing laboratory.

**Let us send you further facts** about this new Microcarb Control. Ask our nearest office, or 4927 Stenton Ave., Phila. 44, Pa.

LEEDS  NORTHROP

Jrl. Ad. TD4-623(4)

OCTOBER 1951; PAGE 3

Metal Progress is published and copyrighted, 1951, by American Society for Metals, 7301 Euclid Avenue, Cleveland, Ohio. Issued monthly;

subscriptions \$7.50 a year. Entered as second-class matter Feb. 7, 1921, at the post office at Cleveland, Ohio, under the act of March 3, 1879.



**AIRCO  
ACCURACY...  
PRECISION ... OPERATING ECONOMY**

*designed into the all new*

**AIRCO NO.50  
TRAVOGRAPH**

Airco's NEW No. 50 Travograph is a rugged, all-welded gas cutting machine. Its massive, long-lived design is engineered to give fingertip sensitivity to all production operations. Used as a basic tool for multi-torch shape cutting, squaring or beveling, its outstanding accuracy slashes reject loss and working costs to a minimum.

Today's most modern production tool, the rugged new Airco No. 50 Travograph precision-cuts steel—light plates, heavy slabs, billets, forgings—to close tolerances. Here are the reasons for its remarkable exactness . . . the "why" it guarantees faithful reproduction.

1. All-welded construction provides a combination of ruggedness, resistance to vibration, and precision operation.
2. Rigidity built into the torch-bearing pantograph arms enables the torch bar to support a uniform load of 500 lbs!
3. Perfectly-balanced when properly set on 16' rails.
4. Ball bearings in the hinge joints make it extremely smooth operating.

**GAS CUTTING MACHINE**

For greatest operating flexibility, the new No. 50 Travograph can be equipped with three distinctly different tracing devices—manual, magnetic, or the full-automatic "Electronic Bloodhound". The "Electronic Bloodhound" needs only an outline drawing or silhouette to cut the most intricate shapes smoothly, sharply, quickly . . . and with extreme accuracy.

If your production line requires quantity flame shaping operations . . . and if close precision cutting would lower your finish-machining costs . . . it will pay you to investigate Airco's new No. 50 Travograph. For complete information write your nearest Airco office for the new catalog just coming off the press.



**AIR REDUCTION**

AN AIRCO COMPANY • AIR REDUCTION MANUFACTURING COMPANY  
AN AIRCO COMPANY  
IMPORTED INTERNATIONALLY BY AIRCO COMPANY INTERNATIONAL  
Divisions of Air Reduction Company, Incorporated  
Dealers and Offices in Principal Cities

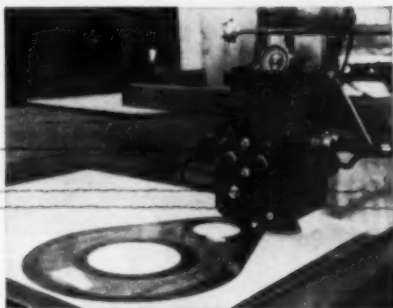
**AIR REDUCTION . . . PIONEER**



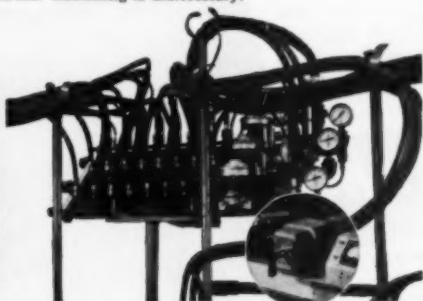
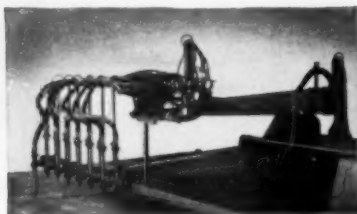
**WIDE CUTTING RANGE** — The No. 50 Travograph cuts circles up to 144" and any shape that does not exceed 92" x 144" on one side. Carriage speeds range from 2" to 35" per minute on the low side; 10" to 168" on the high side, permitting a wide cutting range and allowing high speed positioning over the work.



**SELF-SUPPORTED MANIFOLD** — This individual pantograph arm supports the entire weight of the gas distribution equipment, and is guided by the tracer bar, so that the manifold-torch relationship remains constant. The useful load capacity of the tracer bar is greatly increased because it carries no gas equipment except torches.



**ELECTRONIC TRACING DEVICE** — The Electronic Tracer assures faithful reproduction with extreme accuracy. An outline drawing or a paper cut-out, is easily prepared. Inside and outside square corners, obtuse and acute angles, long slim projections, narrow slots and intricate contours—in any quantity—are all possible with this tracer. It follows the outline automatically, and so accurately that in most cases further machining is unnecessary.

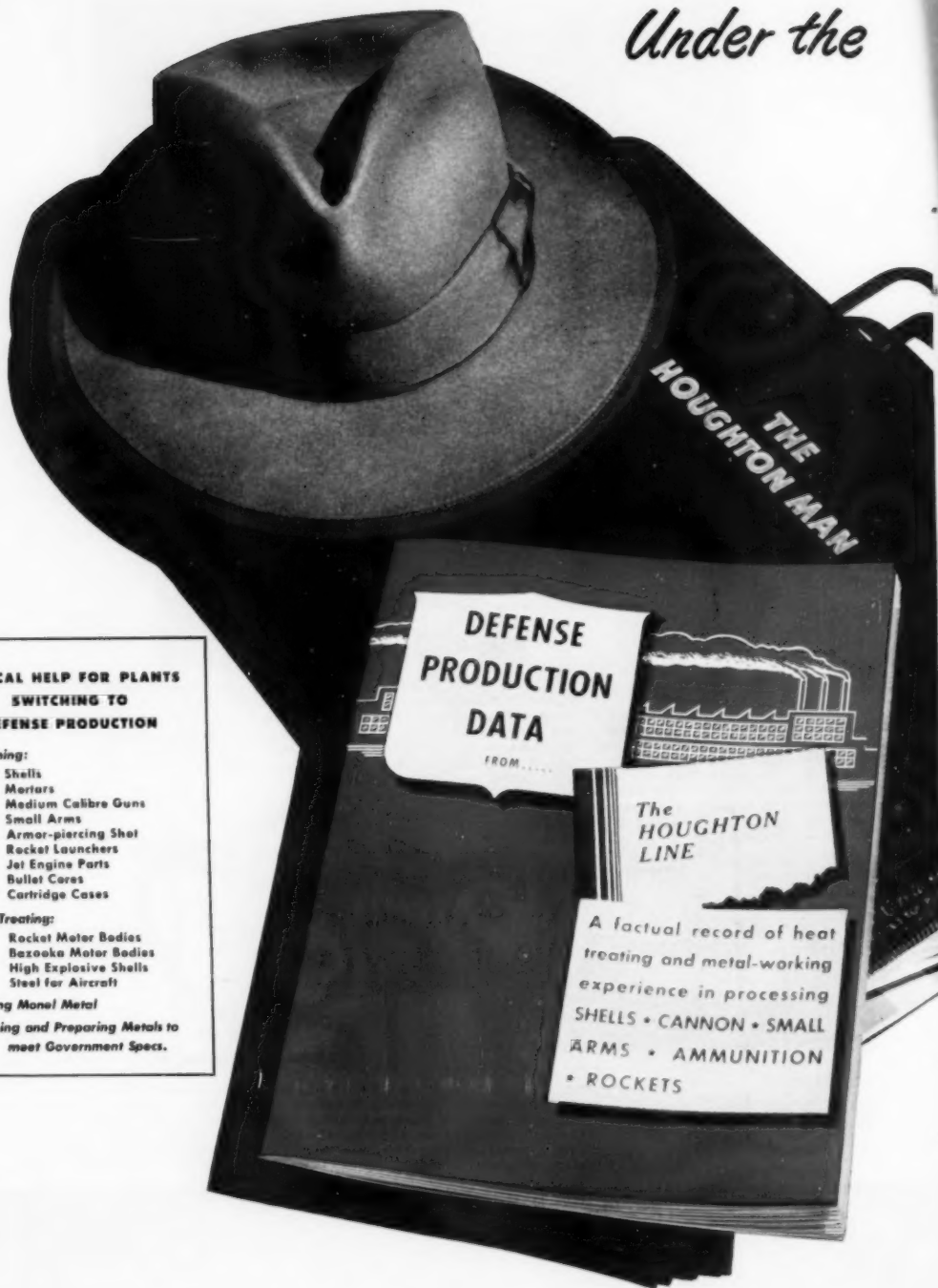


**GAS DISTRIBUTION SYSTEM** — A twist of the selector switch located on the remote control box at the "operator's station" gives complete control of preheating gases and cutting oxygen. This operates one to eight torches, and assures a properly adjusted flame for repetitive cutting operations. This remote control is made possible by solenoid operated valves located on the manifold.

DESIGNERS OF FLAME CUTTING MACHINES FOR EVERY PURPOSE



*Under the*



**TYPICAL HELP FOR PLANTS  
SWITCHING TO  
DEFENSE PRODUCTION**

**Machining:**

Shells  
Mortars  
Medium Calibre Guns  
Small Arms  
Armor-piercing Shot  
Rocket Launchers  
Jet Engine Parts  
Bullet Cores  
Cartridge Cases

**Heat Treating:**

Rocket Motor Bodies  
Bazooka Motor Bodies  
High Explosive Shells  
Steel for Aircraft

**Forging Monel Metal**

**Cleaning and Preparing Metals to  
meet Government Specs.**

**DEFENSE  
PRODUCTION  
DATA**

FROM.....

**The  
HOUGHTON  
LINE**

A factual record of heat  
treating and metal-working  
experience in processing  
SHELLS • CANNON • SMALL  
ARMS • AMMUNITION  
• ROCKETS

# Houghton man's hat there's help for you...

• Getting out into the shop as Houghton men are invited to do, they meet up with a whale of a lot of metalworking problems.

They're continually called on for help in solving problems like these: meeting high physicals in the heat treatment of "lean alloy" steels ... boosting machine output and reducing rejects ... developing lubrication that stands up under all operating temperatures ... cleaning metals faster at lower cost ... preventing idle equipment from rusting ... deep drawing safely at extreme pressures ... and so on.

By working on such a wide variety of problems Houghton has accumulated a lot of metalworking "know-how". We keep careful tabs on success stories through research data and field reports. And all of this information is constantly studied to find out how it can be more widely applied to help the whole metalworking industry.

Because of this vast metalworking experience Houghton men are called on repeatedly for aid—particularly by plants faced with unfamiliar conversion problems. Two-thirds of our sales and research organization today, are vet-

erans of World War II production experience.

Now another rearmament program is getting into full swing. Changes on the production line are popping up again. And Houghton men are busy helping customers lick *today's* problems.

Your Houghton man can help you with many of your problems right on the spot. He can also draw on the wealth of production data our research staff has at its fingertips. For example, the list at the left shows some typical help we can offer on defense production today.

Meantime, to make some of our extensive experience immediately available to you, we have put it into quick reference form. Called "Houghton Defense Production Data", this 60-page illustrated book provides you with information that may save endless hours of searching—and costly trial-and-error experimenting.

Get timely help with your conversion problems by sending today for your copy of this valuable book. Fill out and mail the coupon to E. F. Houghton & Co., 303 West Lehigh Avenue, Philadelphia 33, Pa.



Ready to give you  
on-the-job service ...

E. F. Houghton & Co.  
303 West Lehigh Avenue, Philadelphia 33, Pa.

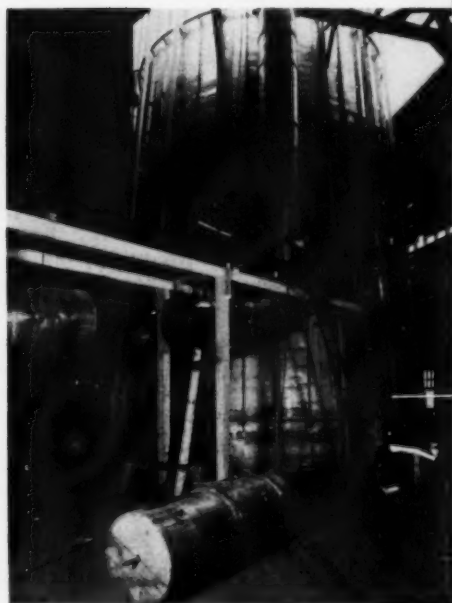
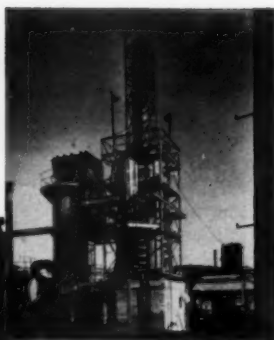
Please send us a free copy of the new 60-page book,  
"Houghton Defense Production Data"



Name \_\_\_\_\_ Title \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

Metal Cleaners, Rust Preventives, Foundry Core Binders, Quenching Oils, Salt Bath Materials, Lubricants and Greases

Mills-Packard towers used in the manufacture of sulfuric acid by the chamber process are constructed entirely of sheet lead supported in a steel frame. The lead is cooled externally by water flowing down the sloping sides.

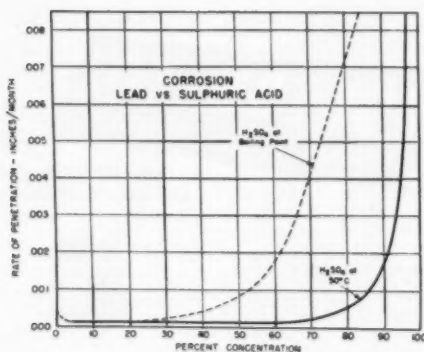


Electrostatic precipitator of the type used throughout the oil refining and chemical industries to prevent air pollution by sulfuric acid mist. Lead construction throughout, supported in steel framework.

## for handling corrosive chemicals **lead** is basic

Lead, known in the middle ages as a *base* metal, to set it apart from the noble metals, is regarded in fact as a *basic* metal in the modern age. In the chemical process industries, indeed, lead has proved virtually indispensable. Of all the common metals, lead is the most corrosion-resistant in contact with industry's most-used chemicals—especially sulfuric acid, the principal chemical of the vast process industries. Lead has the unique property of forming automatically upon its surface a protective coating of insoluble and tightly adherent lead salts, thus setting up an effective barrier that prevents further corrosion of the metal.

While lead is unusually resistant to corrosion, it also is unusually receptive to manipulation, so to speak. Rolled in sheets, lead is readily formed to make linings for tanks and all manner of vessels for the handling of acids. Extruded in tubular form, or cast in molds or dies, lead makes pipe, coils and innumerable other items for use with corrosive solutions. Furthermore, lead, as a material of construction, is "manageable" in the field and on the job. Lead is inseparably joined by a simple "burning" or welding process without further heat treating or annealing. The adaptability of the metal is also a distinct advantage in meeting unexpected on-site conditions. Finally, of all the common materials used for chemical construction, lead is the most easily salvaged and a higher proportion of it is salvageable.



Courtesy: LEAD INDUSTRIES ASSOCIATION

### ST. JOSEPH LEAD CO.

250 PARK AVENUE, NEW YORK 17, NEW YORK • Eldorado 5-3200  
THE LARGEST PRODUCER OF LEAD IN THE UNITED STATES

# get your free copy of this valuable brazing book!

SEE SILVALOY WORKING EXHIBIT BOOTH G-340 DETROIT METAL SHOW OCTOBER 15-19th! AT MICHIGAN STATE FAIR GROUNDS - DETROIT



## SILVALOY

A COMPLETE GUIDE TO SUCCESSFUL SILVER BRAZING...

## SILVALOY



**NEW!** This 48-page, pocket-size, fully illustrated book is an easy-to-read-and-understand manual that will tell you everything you want to know about low-temperature silver brazing, brazing alloys, joint designs, preforms, plymetal, fluxing, heating methods, cleaning and inspection. There are also many useful reference charts, including Specifications for Silver Brazing Alloys, Check list of Government Specifications, Conversion Data, Brazing Alloy Quantities by Weight, a graph to determine

thermal expansion of metals at silver brazing temperatures, etc.

This book is a complete and compact library of brazing data that every design and production engineer—every brazing technician and buyer of brazing materials should have! It is the most complete guide you can get to all aspects of silver brazing applications and problems.

Be sure that you reserve and receive a free copy for yourself! Fill in the coupon below—mail it today! ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

## THE AMERICAN PLATINUM WORKS

231 NEW JERSEY RAILROAD AVENUE, NEWARK 5, NEW JERSEY



NOTE: IF EXTRA COPIES ARE DESIRED FOR BRAZING PERSONNEL PLEASE SEND REQUEST ON COMPANY LETTERHEAD.

THE AMERICAN PLATINUM WORKS, INC.  
231 New Jersey Railroad Avenue Newark 5, New Jersey  
Gentlemen: Please send me a copy of "A COMPLETE GUIDE TO SUCCESSFUL SILVER BRAZING." I understand this will be sent without cost or obligation.

NAME .....  
COMPANY .....  
ADDRESS .....  
CITY ..... ZONE .....  
STATE .....

# COUPON



Continued high steel production this winter  
may depend on . . . **CLEANING OUT**  
→ **YOUR SCRAP**  
**THIS MONTH**

**HOW TO TURN SCRAP INTO MONEY**  
with an organized dormant scrap round-up  
in your plant:

1. Appoint a top executive with authority to make decisions to head the salvage drive.
2. Organize a Salvage Committee and include a member from every department.
3. Survey and resurvey your plant for untapped sources of dormant scrap. Encourage your employees to look for miscellaneous scrap and report it to the committee.
4. Sell your entire organization on the need to scrap unusable material and equipment.
5. Prepare a complete inventory of idle material and equipment. Tag everything not in use.
6. Start it back to the steel mills by selling it to your regular scrap dealer.
7. **KEEP AT IT!**

**\*DORMANT SCRAP** is any obsolete, broken or worn-out and irreparable machinery, tools, equipment, dies, jigs or fixtures, etc., that may encumber your premises.

Despite . . . and because of . . . the continued high rate of steel production, the steel industry is on a hand-to-mouth basis in its receipts of purchased scrap . . . essential to production! Mills that normally inventory a 60 day supply of scrap, are now maintaining high production with less than a week's supply on hand. That the effect of winter on transport facilities could quickly exhaust these dangerously meager scrap inventories . . . and thus force a cut in steel production . . . is obvious. Help assure an uninterrupted steel supply by rounding up and selling your dormant scrap\* to your regular scrap dealer this month!

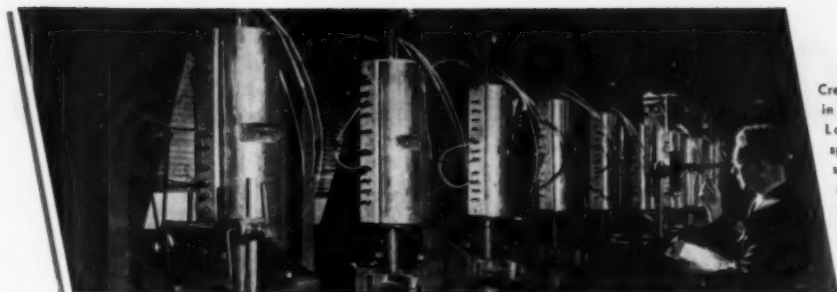


**INLAND  
STEEL COMPANY**

38 South Dearborn Street

• Chicago 3, Illinois





Creep tests under way in INCO's Research Laboratory. Here specimens of heat-resisting alloys are held under constant load at temperatures up to 2100°F.

## IS HIGH-TEMPERATURE PERFORMANCE YOUR PROBLEM? INCO Engineers may have the answer...

**Y**our successful selection of metals for high-temperature operations often requires more than a simple evaluation of mechanical properties of the material itself.

The most important factor may be a specific corrosive condition linked to the elevated temperature-environment—a trouble not apparent, perhaps, at moderate thermal levels. And as the trend to higher operating temperatures develops, new high-temperature corrosion problems follow.

Engineers who encounter high-temperature problems in their work with design, production, and operations may find Inco High-Temperature Engineering Service a valuable source of information.

### INCO'S HIGH-TEMPERATURE ENGINEERING SERVICE

As industry progressed, it used higher temperatures and required metals and alloys to withstand these temperatures. Inco Engineers have endeavored to assist by analyzing the requirements and furnishing experimental data for the selection of the material.

Inco laboratory facilities at Bayonne, N. J., and Huntington, W. Va., have assembled data on mechanical properties of metals at high temperatures... and performance under corrosive conditions. Constant research

is adding to this fund of information. Inco Engineers in the field are learning of conditions that cause unsatisfactory performance and how best to remedy them.

In a field that grows so fast, it is obviously impossible to have an immediate answer to every problem. But each new problem solved or studied adds to the total of knowledge on the subject. So if you are having high-temperature problems—whether in an existing application or with a new project, let the Inco Engineers work with you. Send for our High-Temperature Work Sheet, a simplified form to set out your full story. And you may find that Inco can suggest an answer to your problem.

Send for your copy of this new High-Temperature Work Sheet; it simplifies gathering the full story of your problem.



**THE INTERNATIONAL NICKEL COMPANY, INC.**  
67 Wall Street, New York 5, N. Y.

# SHORTEST ROUTES to new

## Outstanding DYNALOG<sup>\*</sup> Electronic Recorders and Controllers

The extreme simplicity of Dynalog Electronic Instruments results in unmatched accuracy, sensitivity, and speed — plus unequalled freedom from maintenance. Designed to take full advantage of electronic circuits, these instruments provide completely stepless, continuous balancing. Full-scale to complete balance in as little as one second (3 seconds, standard). Dynalog is the only potentiometer that has:

**NO SLIDEWIRE**

**NO GALVANOMETER**

**NO HIGH-SPEED BALANCING MOTOR**

**INDICATORS, RECORDERS AND CONTROLLERS** Available for temperatures up to 2800°F. with thermocouples, and up to 600°F. with resistance bulbs; for pH with Beckman electrodes; for blast air moisture with the Foxboro Dewcel; for force cells and weight cells. Controllers supplied with either pneumatic or electric control systems. For on-off, proportioning, or automatic reset control.



Dynalog Controller

**NO STANDARDIZING  
NO BATTERY**



Multi-Record Dynalog

### The Multi-Record DYNALOG

Measures and records a point every 6 seconds — up to 6 different points — in 6 distinctive non-blurring colors. The single pen arm positively synchronizes all records in respect to the time arcs on the chart. Records are easy to read; the circular charts are economical and convenient to file.

### The Segmental Chart DYNALOG

Records 24 points on one chart at one minute interval per point. 24 points in 25 minutes. Economical for supervisory records on a large number of slowly changing temperature points such as furnace walls and roofs, bearings, etc.

<sup>\*</sup>Reg. U. S. Pat. Off.

RECORDING • CONTROLLING

# efficiencies in metal working

## ECONOMICAL TEMPERATURE CONTROL for furnaces and ovens

Top performance of the Type 4000 non-recording controllers has been proven over many years of service. A single motor can operate up to 5 instruments . . . affords large savings in both initial and operating costs. Control is electric . . . action, on-off or proportioning.



Type 4000  
Non-Recording Controller

## SCHEDULE CONTROL for repetitive time- temperature cycles

When used with Type 4000 controller, this time-temperature cam-setting unit varies control point to carry out any program. Different rates of rise, holding periods and other variations can be combined on the same cam. Mechanism is extremely simple and trouble-free. Aluminum cam blanks, printed with time and temperature scales, are easy to lay out and cut.



Program Controller

## STRONG ACID PICKLING with the Type 4000 non-recording temperature controller

Simpler, fewer, larger, and more rugged parts make the Type 4000 particularly free from maintenance problems and expense. The electrical measuring system permits controller to be located any distance from bath, away from corrosive atmosphere.

Foxboro strong-acid thermocouples stand up in severe pickling solutions. Reduce maintenance costs and interruptions in service.

## FUEL, AIR, AND WATER PRESSURES

With Foxboro pressure indicators, recorders, or automatic controllers; gas or oil pressures for furnace burners can be maintained efficiently . . . compressors and hydraulic systems controlled accurately . . . steam pressures properly indicated or recorded . . . and many similar functions performed to streamline costs. All standard ranges between 1" of water and 80,000 lb.



Pressure Recorder

## FLOW OF FUEL, AIR, WATER, STEAM

Foxboro Flow Meters accurately record flow to show plant, department, or operation consumption of gas, oil, steam, water, or air. For operating pressures up to 5,000 lb. Can be equipped with integrators to totalize flow. On many processes, pressure or temperature records can be combined on the same chart with the record of flow. Also available: automatic flow controllers.



Flow Meter for Fuel, Air and Water

## ELECTROPLATING TEMPERATURE CONTROLS

Accurate, automatic control of heating or heating and cooling in plating tanks, cleaning baths, degreasers, and wash tanks by this compact instrument assures top quality at low cost. The Foxboro Model 41 meets the demand for an inexpensive indicating controller that gives unexcelled performance. Bells of Type 316 Stainless Steel, to resist corrosion and eliminate maintenance, are standard.

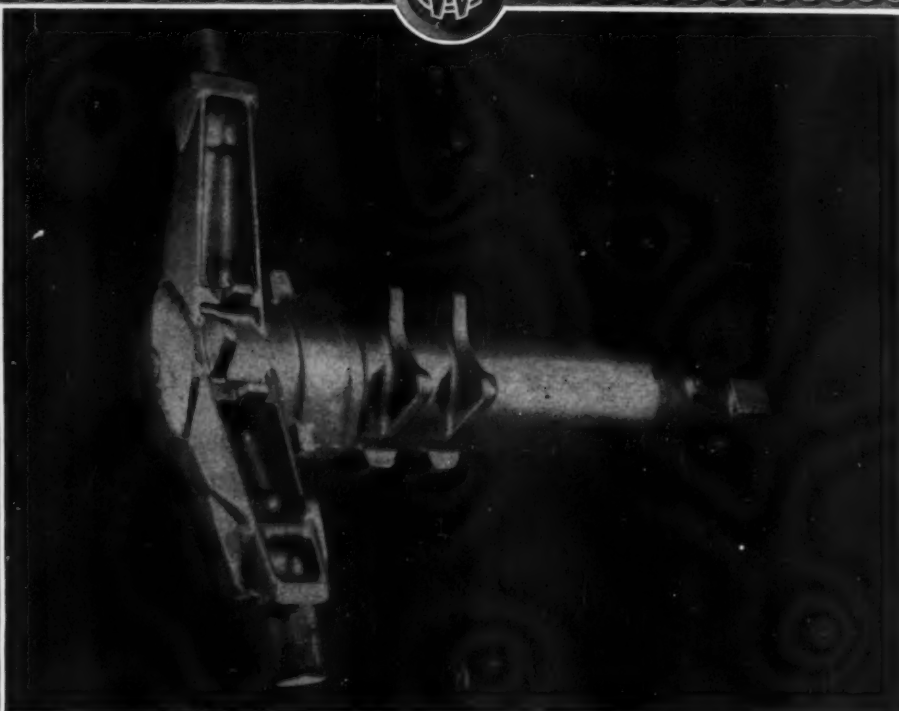


Model 41 Temperature Controller

✓ Check all the features of these instruments for help in bringing maximum economies to your plant. Write for complete data. The Foxboro Company, 5210 Neponset Ave., Foxboro, Mass., U. S. A.

INDICATING INSTRUMENTS BY

**FOXBORO**  
REG. U. S. PAT. OFF.



*Forgings* for the aircraft industry today demand the utmost in engineering and production techniques and in scientific laboratory control. This massive complicated landing gear component, weighing over 400 pounds, is typical of Wyman-Gordon's forging contribution to the ever-growing progress in aircraft design. In crankshafts for the automotive industry and in all types of aircraft forgings, steel and light alloy, Wyman-Gordon has pioneered in the development of forging "know-how"—there is no substitute for Wyman-Gordon experience.

*Standard of the Industry for More Than Sixty Years*

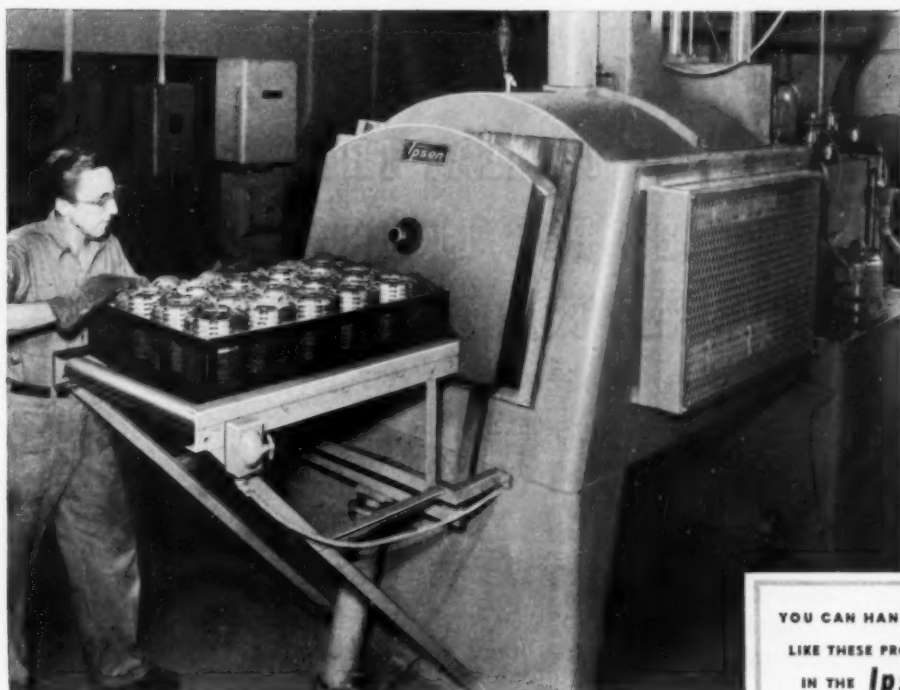
# WYMAN-GORDON

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL

WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS

DETROIT, MICHIGAN



See this  
Equipment  
at METAL SHOW  
Booth F-360

## 4 Important Production Advantages with New **Ipsen** HEAT TREATING UNIT

Designed for carbonitriding, carburizing, hardening, brazing, and mar-tempering, new Ipsen Automatic Production-Type Heat Treating Units offer outstanding production and metallurgical advantages in processing a wide variety of workpieces. The features outlined below are essentially the reasons why more than 75 plants in the past two years have selected, and are today using, Ipsen Equipment to speed heat-treating operations and cut costs:

**1 AUTOMATIC OPERATION**—from heat through quench (or cooling), reduces work handling, eliminates guess work, assures uniform results on a production basis.

**2 BRIGHT, CLEAN, SCALE-FREE WORK**—with sealed atmosphere control. Eliminates cleaning and processing operations prior to and following heat-treatment, effects substantial savings in production costs.

**3 CRACKING AND DISTORTION REDUCED**—by controlled quenching with two-speed oil circulation and automatic temperature regulation.

**4 FAST, EFFICIENT PROCESSING**—versatile and easy to handle variety of work, no idle time for change overs, no danger of burning or marring, quick burn-off. Saves time, increases output.



**Write TODAY FOR MORE FACTS** . . . Ask for free bulletins and find out how Ipsen Heat-Treating Units and methods can be applied to your work. If you wish, samples or production lots of your work will be run, proper procedures established, and results predetermined without obligation.



**IPSEN INDUSTRIES, INC.** 715 South Main Street, Rockford, Illinois  
Production Units for CARBONITRIDING • CARBURIZING • HARDENING • BRAZING • MARTEMPERING

YOU CAN HANDLE JOBS  
LIKE THESE PROFITABLY  
IN THE **Ipsen**



Piler Segment—  
C1045 Clean hard-  
ened. Finish Grit  
eliminated.



Gear — C1020 —  
carbonitrided.  
Cleaning before  
plating elimi-  
nated.



Valve — C1020  
welded to C1045—  
stress relieved and  
hardened. Bur-  
ring operation  
eliminated.



Release Lever—  
carbonitrided 500  
per hour. Blast-  
ing eliminated.



Heavy Bull Gear Pinion  
SAE 8670 — carburized 39  
per hour.

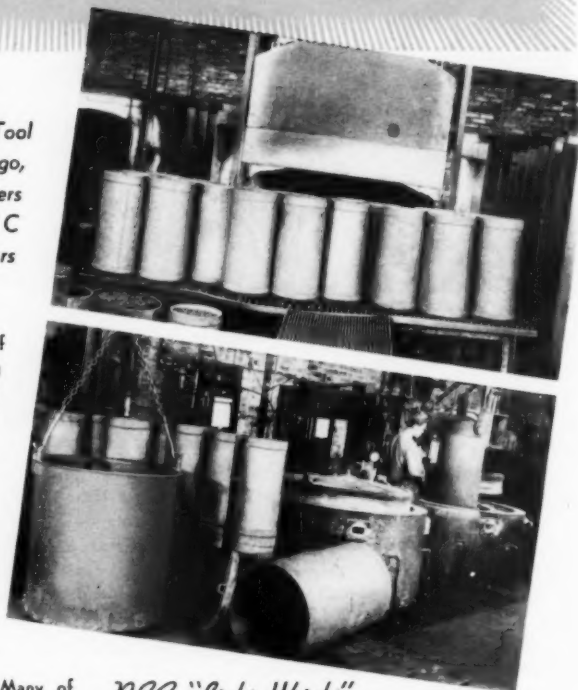


# MANY VIP IN HEAT-TREAT FIELD HAVE USED PSC 'LIGHT-WEIGHT' EQUIPMENT FOR OVER 20 YEARS

*Very Important People Are Perfection Tool and Metal Heat Treating Co. of Chicago, One of Largest Commercial Treaters in Nation. They Have Used PSC Containers Exclusively for Over 20 Years*

**P**ictured at right are views in plant of Perfection Tool & Metal Heat Treating Co. of Chicago, showing PSC heat-treating containers in use. One of the foremost commercial heat-treaters in the country, Perfection has been employing PSC "Light-Weight" equipment exclusively since 1929, the year they placed their first order. Suggesting the many different types of containers and fixtures we supply Perfection, they use thirty different sizes of the carburizing boxes pictured at top.

Among the users of PSC heat-treating units are the majority of the metal-working firms in America today. Many of them have been users since the late 20's when this new light-weight, welded alloy equipment was introduced. PSC units furnished in any size, design or metal specification: annealing and carburizing boxes, fixtures, retorts, covers, etc. Send blue prints or write as to your needs.



## *PSC "Light Weight"*

**Heat-Treating Equipment for Any Product and Any Metal**

Carburizing and Annealing Boxes  
Baskets - Trays - Fixtures  
Muffles - Retorts - Racks  
Annealing Covers and Tubes  
Pickling Equipment

Tumbling Barrels - Tanks  
Cyanide and Lead Pits  
Thermocouple Protection Tubes  
Radiant Furnace Tubes and Parts  
Heat, Corrosion Resistant Tubing

## THE PRESSED STEEL COMPANY

of WILKES-BARRE, PENNSYLVANIA

*Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING Sheet Alloys*

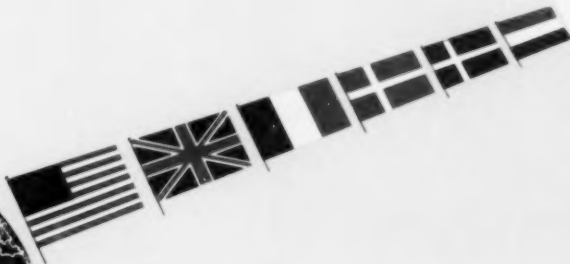
☆☆☆ OFFICES IN PRINCIPAL CITIES ☆☆☆

## *Lindberg paroli universala lingvajo kie ajn metalo estas fabrikid*

Yes — "Lindberg speaks the universal language wherever metal is fabricated" — that's the translation of the headline in Esperanto — the universal language!

And in the many parts of the world where Lindberg Furnaces are manufactured and used, you'll find these furnaces speaking another universal language — the one that needs no translation — the language of production men.

The following pages show some foreign installations of hard-working Lindberg furnaces — some shipped from the United States, but most of them built from Lindberg drawings by our world-wide network of manufacturing affiliates.



## *Lindberg . . . in any language means finer furnaces*

### **J. J. Zimmer & Zonen, Amsterdam**

Wij stellen het zeer op prijs U hiermede te berichten, dat de Lindberg oven, welke reeds enige jaren met veel succes dag en nacht in ons bedrijf in gebruik is, thans met evenveel succes werkt in onze nieuwe afdeling: Staalharderij.

In onze zeer modern ingerichte loonstaalharderij, waarin voor een paar duizend binnenlandse bedrijven de onderdelen worden gehard, heeft de Lindberg oven veel bijgedragen om onze productie te verhogen.

We beg to inform you herewith that the Lindberg furnace, which has already been successfully day and night in use in our plant, is working at the moment with as much success in our new department: Steelhardening.

In our very modern equipped commercial hardening shop, in which the parts for a couple of thousand inland firms are hardened, the Lindberg furnace has done much to increase our production.



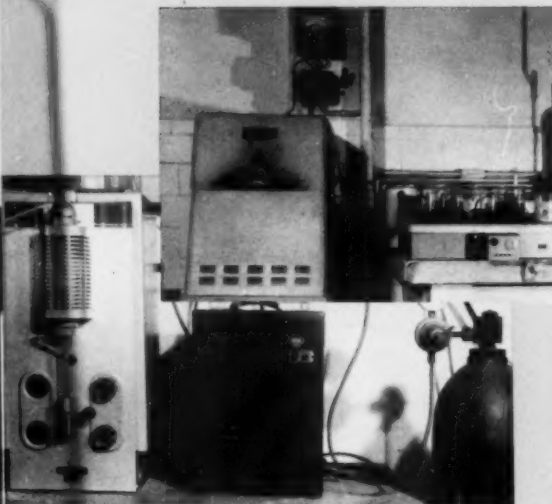
### **Ministério Da Agricultura Departamento Nacional Da Produção Mineral Laboratório Da Produção Mineral, Rio De Janeiro, D. F.**

Atendendo ao pedido dos representantes no Brasil da Lindberg Engineering Co., de Chicago, Estados Unidos da America do Norte, declaramos ter em funcionamento, em nossos laboratorios, diversas placas aquecedoras e fornos eletricos, fabricados pela Lindberg.

Todo esse material vem funcionando a inteiro contento de nossos tecnicos.

At the request of the representatives in Brazil of the Lindberg Engineering Co., Chicago, U.S.A., we declare that we have in use, at our laboratories several hot plates and electric furnaces manufactured by Lindberg.

All the above material is entirely satisfactory to our technicians.

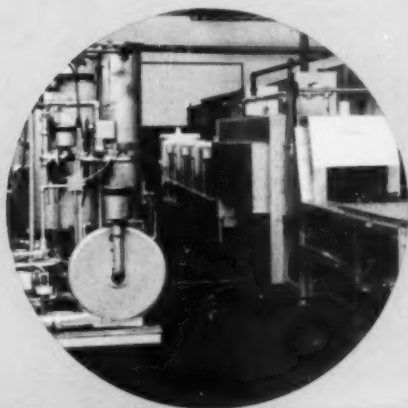


### **Fiat, Sezone Automobili, Torino**

I nostri forni Lindberg funzionano ottimamente. Ci é gradita l'occasione per porgerVi i ns/ più distinti saluti.

Our Lindberg Furnaces function perfectly.

On this pleasant occasion we present our distant salutation.



## *Lindberg in foreign lands*

Electric Resistance Furnace Co.  
Weybridge, Surrey, England

Electric Furnace Co.  
Weybridge, Surrey, England

Etablissements Jean Aube  
Paris, France

Gerard Plueger  
Antwerp, Belgium, Laboratory Furnaces  
Allmet Industries Pty., Ltd.  
Sydney, Australia

A. Schuabarth & Co.  
Basle, Switzerland

Sabin St. Germain  
Mexico, South America

Williams & Wilson  
Quebec, Toronto, Montreal,  
Windsor, Canada

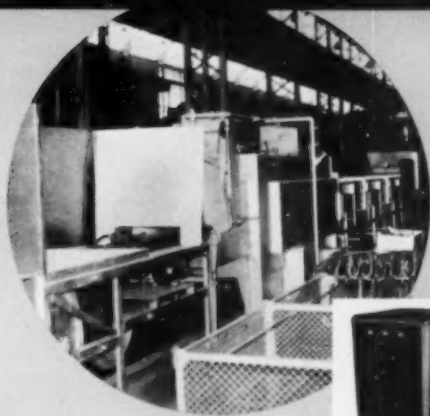
Lindberg Italiana  
Milan, Italy

Impresa Progresso  
Rio de Janeiro, Brazil, Laboratory Furnaces

Lutz Ferrando y Cia  
Buenos Aires, Argentina

Ing. G. W. Berg & Co.  
Helsingfors, Finland

Axel Kistner  
Stockholm, Sweden



### **Innocenti, Milano**

Abbiamo installato i Vs. forni che funzionano da tempo con ns. completa soddisfazione. Siamo lieti di farVi questa dichiarazione e di segnalarVi che, grazie ai Vs. impianti, abbiamo ottenuto notevoli vantaggi sia nella qualità del prodotto, sia nel costo di produzione.

Vogliate gradire, coi ns. ringraziamenti, i ns. migliori saluti.

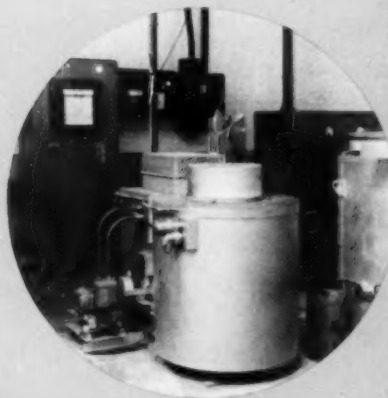
We have installed your equipment which functions with complete satisfaction. We are happy to declare and signify our thanks to you and all the employees. We have kept complete books, which prove the advantages and profit and also the quality of the product and the low cost of production. We thank you very much and send greetings.



### **La Compagnie Singer, Paris**

Les fours Lindberg construits sous licence par les Etablissements Jean Aube & installés dans nos ateliers nous donnent entière satisfaction.

The Lindberg Furnaces built under licence by Jean Aube and installed in our shop give us complete satisfaction.



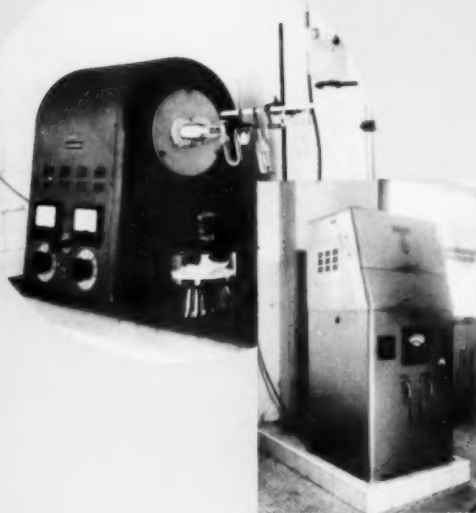
**Ministerio Do Trabalho, Industria E Comercio  
Instituto Nacional De Tecnologia, Rio de  
Janeiro, D.F.**

Dentre a aparelhagem de aquecimento existente na Divisão de Indústrias Metalúrgicas, ocupam lugar proeminente, as placas aquecedoras H-2 e os fornos CR-5, CF-1, B-2 e G-10, tôdos de fabricação de Lindberg Engineering Co.

O uso constante que vem fazendo esta Divisão, há mais de cinco anos, de tais equipamentos com absoluto sucesso quanto à perfeição de funcionamento, atesta eloquentemente a alta qualidade de sua fabricação, que não despreza aliás as linhas estéticas, bem características das placas aquecedoras e dos fornos Lindberg.

Amongst the heating apparatus existent at the Metallurgical Industries Division, the hot plates H-2 and the furnaces CR-5, CF-1, B-2 and G-10, all manufactured by the Lindberg Engineering Co., occupy a prominent place.

The constant use that this Division is making of such equipment, for over five years, with absolute success as to the perfect functioning, attest eloquently the high quality of its manufacture, and maintain the esthetic lines, which is quite characteristic of the Lindberg hot plates and furnaces.



Lindberg Melting Furnaces, including the two-chamber aluminum induction furnace illustrated here, are built in England by the Electric Furnace Co. Lindberg Heat Treating Furnaces are built by the Electric Resistance Furnace Co. both of Weybridge, Surrey.

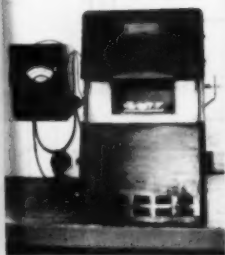


**Société Anonyme John Cockerill  
Seraing (Belgique)**

Veuillez noter que les fours Lindberg qui sont en service en nos usines d'Athus, nous donnent satisfaction.

Agréez, Messieurs, nos salutations distinguées.

You'll kindly note the Lindberg furnaces that are in service in our shops at Athus (Belgium) are giving us satisfaction.



*Lindberg manufactures a complete line of industrial furnaces*

Cyclone Tempering Furnaces  
Super Cyclone High Temperature Convection Furnaces  
Atmosphere Heat Treating Furnaces  
Atmosphere Brazing and Sintering Furnaces  
Atmosphere Generators

Melting Furnaces, Gas, Oil, and Electric  
Two-Chamber Induction Melting Furnaces  
High Frequency Induction Heating Units  
High Frequency Carbon Determinator Units  
Laboratory Furnaces and Equipment

**LINDBERG  FURNACES**

Lindberg Engineering Company, 2450 W. Hubbard Street, Chicago 12, Illinois





## A Day's Output Every Hour

with **UNIONMELT** Welding

Trade-Mark

(Above) UNIONMELT welding a chromium alloy end ring to a mild steel pump shell takes only 1 hour and 23 minutes. Former methods of welding took 10 hours. Ring and shell, each 4 in. thick, are joined in consecutive passes as the work rotates under the UNIONMELT welding head.

(Right) This UNIONMELT welding machine smoothly deposits a sound, corrosion-resistant overlay inside a mild steel pump shell. Stainless steel metal — 20 to 120 lb. of it, depending on pump size — builds up at 20 lb. per hour. Highest former rate was 2 lb. per hour.



In making high-pressure steam pumps, these two welding operations used to take 20 hours—2½ working days. This was cut to 2¼ hours by UNIONMELT welding as shown above. In addition, finishing costs dropped sharply because the UNIONMELT deposits are smoother and need less machining.

High-speed production is common wherever automatic UNIONMELT welding is used to join ferrous or non-ferrous metals. Welds up to 3 in. thick can be made in one pass; light-gage sheet can be welded at speeds up to 200 in. per minute.

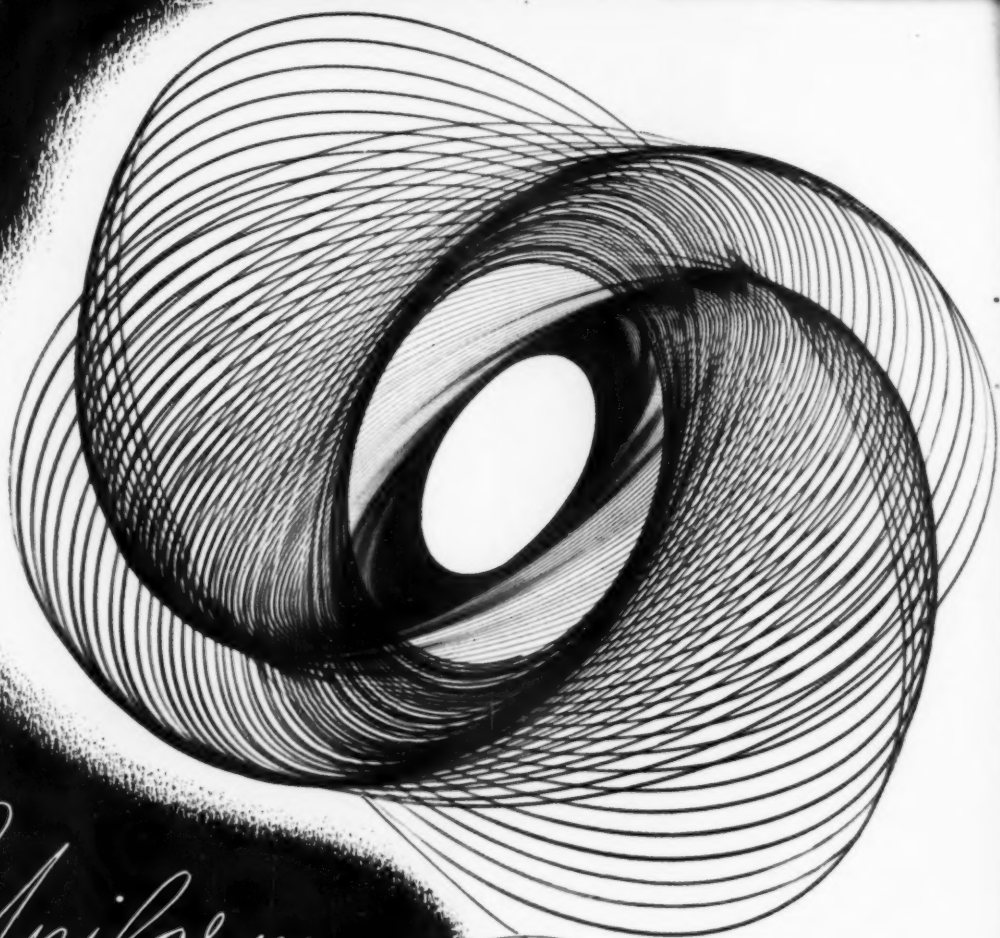
UNIONMELT welding is only one of many time- and moneysaving LINDE methods for making, cutting, joining, treating, and forming metals. So, whatever you do with metals, there is a good chance that LINDE know-how, show-how, and equipment can help you do it better, more quickly, or at lower cost. Telephone or write to our nearest office today. LINDE AIR PRODUCTS COMPANY, a Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in Other Principal Cities. In Canada: Dominion Oxygen Company, Limited, Toronto.

*Unionmelt*

Trade-Mark

**EQUIPMENT AND SUPPLIES**  
for fast, automatic electric welding.  
**No sparks, spatter, smoke, or flash.**

The terms "Linde" and "Unionmelt" are registered trade-marks of Union Carbide and Carbon Corporation.



*Uniform*

**for precision forming  
and coiling**

## **Pittsburgh Oil Tempered Spring Wire**

Your precision forming and coiling operations will be easier, more economical, with Pittsburgh Oil Tempered Spring Wire because it has the uniformity to give you trouble-free performance day after day. Severe bends are easy—it withstands high stresses and resists wear and abrasion.

Each coil of Pittsburgh Oil Tempered Spring Wire has uniform qualities of tough-

ness, tensile strength, reduction of area, and hardness plus superior straightness that will give you ease of operation and excellent finished products.

Pittsburgh Oil Tempered Spring Wire is furnished in a complete range of sizes from .062" through .500" diameter. For information write department MP, Pittsburgh Steel Company, Pittsburgh 30, Pa.

*The Steel Industry Needs Scrap—Keep it Moving*



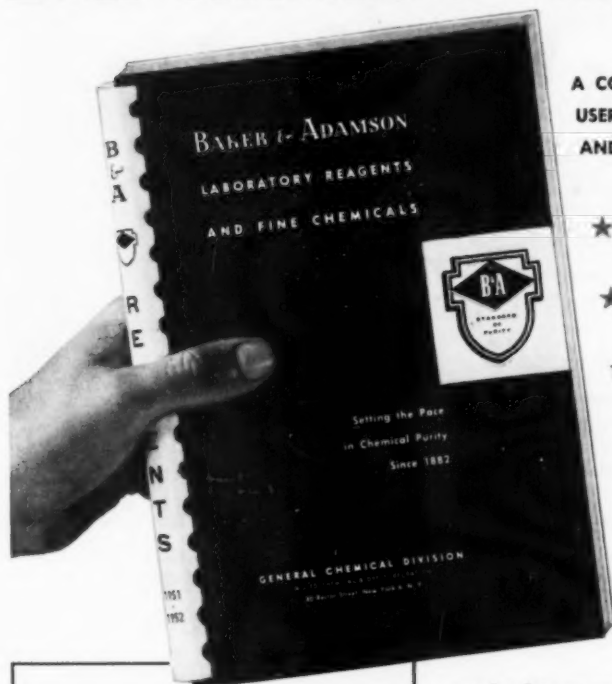
## **Pittsburgh Wire**

**a product of Pittsburgh Steel Company**

# Announcing...

## THE BIG NEW 1951-52

## B & A CATALOG of Reagents & Fine Chemicals



A COMPLETE BUYERS' GUIDE FOR  
USERS OF LABORATORY REAGENTS  
AND FINE CHEMICALS

- ★ For Manufacturing Control Laboratories
- ★ For Production Requiring Quality Chemicals
- ★ For Process Planning and Development
- ★ For Research Laboratories
- ★ For Educational Laboratories

### Packed with helpful information

**STORAGE AND HANDLING:** Special section gives helpful "do's and don'ts" on handling chemicals that require extra precautions.

**PACKAGING SECTION:** Exclusive new feature—photographs and full details on major B&A packaging, including: ...the "PBL" Drum with polyethylene liner, the 9-bottle case for reagent acids, the 6-½ gallon carboy, the "Safepak" plastic dispenser for HF, and many others.

**EXTENSIVE DATA:** Over 230 pages of specifications, other pertinent data on B&A Reagents, also on many Fine Chemicals.

Just off the press—Baker & Adamson's new 1951-52 Catalog is profusely illustrated . . . packed with 264 pages of important information. Gives clear, concise data on over 1,000 B&A Laboratory Reagents and Fine Chemicals! Includes such pertinent facts as grades, strengths, maximum limits of impurities, etc. If you buy or specify laboratory reagents, this new 1951-52 B&A Catalog belongs on your desk. Send for your copy today.

**Write  
Today**

Fill out coupon, attach to your business letterhead and mail today. Free to all qualified users and buyers of reagents.

**BAKER & ADAMSON PRODUCTS, General Chemical Division**  
ALLIED CHEMICAL & DYE CORPORATION  
40 Rector Street, New York 6, N. Y.

Please send me your new 264 page catalog of Baker & Adamson Reagents and Fine Chemicals for 1951-52.

Name

Organization  Position

Address

City  Zone  State

*any location  
any capacity*

**Just name the place . . . and**

## **AQUATOWER or VAIRFLO**

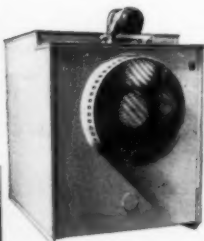
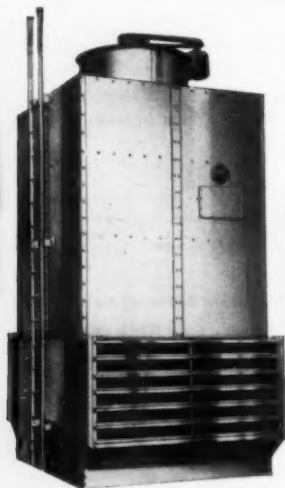
**will do the water cooling job!**

Indoors or out . . . on the ground or on the roof . . . on the top floor or in the basement—there's a Marley cooling tower designed to fit any location and any cooling requirement.

If your job is in the 3-ton to 60-ton range, you need an adaptable Aquatower—the compact, trouble-free cooling tower for indoor or outdoor use. Aquatowers are made in nine sizes and two styles to do each specific job economically. They are shipped completely assembled or “knocked-down” for easy assembly on the job.

In larger capacity installations the answer is a versatile Marley Vairflo . . . a broad range cooling tower with all the quality “extras” ordinarily found only in heavy-duty, high priced towers. The Vairflo, in steel or wood, harmonizes with architectural design. All material in Vairflos is completely prefabricated for simple job erection.

Whatever your need, select a Marley tower backed by the Marley guarantee and the “know-how” gained in more than 25 years of leadership in the water cooling industry. For more information, write for Marley bulletins AQ-51 and V-51, or call the Marley representative in your city.



also producers of  
DOUBLE-FLOW TOWERS  
CONVENTIONAL TOWERS  
DRICOOLES  
NATURAL DRAFT TOWERS  
SPRAY NOZZLES

**The Marley Company, Inc.**

KANSAS CITY 15, KANSAS





**COSTS DOWN 25%  
PRODUCTION UP 100%**

**WHEN STRESSPROOF® REPLACED  
HEAT-TREATED .40 CARBON  
ALLOY STEEL BARS**

• **Speeded  
Machining**  
50% to 100%

• **Eliminated  
need for**  
**Heat Treated  
Alloy Bars**

In this asphalt road layer, instead of using a heat-treated, hot-rolled .40 carbon alloy bar, STRESSPROOF was specified. STRESSPROOF provided *in-the-bar* the necessary strength and wear resistance, and machined so much easier that production time was cut in half.

STRESSPROOF's unique combination of four important qualities *in-the-bar* is cutting costs and speeding production on many similar defense jobs. STRESSPROOF is twice as strong as ordinary cold-finished bars. Its resistance to wear often makes carburizing unnecessary. It is stress-relieved to minimize distortion, and has *in-the-bar* machinability fully 50% better than heat-treated alloys of the same hardness. Yet STRESSPROOF is less expensive than all cold-finished and most hot-rolled alloy steel bars that have been fully heat treated.

STRESSPROOF is also available with a Ground and Polished finish.

**LASALLE STEEL CO.**  
1424 150th Street, Hammond, Indiana  
Manufacturers of the Most Complete Line of Cold-Finished  
and Ground and Polished Bars in America

*LaSalle*  
**STRESSPROOF**

**STRESSPROOF**  
IS PLAYING A VITAL ROLE  
IN NATIONAL DEFENSE!

A very large proportion of STRESSPROOF production, today, is going into defense jobs. However, from time to time sample bars may be available for testing purposes.





# RIEHLE

## SCREW POWER UNIVERSAL TESTING MACHINES with

### 5 SCALE RANGES

PRECISE LOAD  
INDICATION FOR  
ALL YOUR TESTS



#### BUILT IN 11 SIZES

2,000 LBS.	30,000 LBS.	160,000 LBS.
5,000 LBS.	60,000 LBS.	200,000 LBS.
10,000 LBS.	120,000 LBS.	300,000 LBS.
20,000 LBS.		400,000 LBS.

Only Riehle gives you 5 separate ranges in every Screw Power Universal Testing Machine . . . the equivalent of 5 complete machines in 1.

5 scale ranges give you precise coverage over the machine's full capacity and permit you, by a turn of the range selector knob, to choose the range most applicable for any given test.

"ONE TEST IS WORTH A THOUSAND EXPERT OPINIONS"

## RIEHLE TESTING MACHINES

Division of  
AMERICAN MACHINE AND METALS, INC.

East Moline, Illinois

Representatives in Principal Cities

FOREIGN SALES OFFICE: Woolworth Building, New York 7, N. Y.

#### ACCURATE-CONVENIENT-DEPENDABLE

Other Riehle features you'll like are the fool-proof Pendomatic Indicating Unit . . . accuracy guaranteed within  $\frac{1}{2}$  the normal tolerance allowed by ASTM and Federal specifications . . . exceptionally low weighing table . . . low over-all height . . . easy installation and distinctive streamlined appearance.

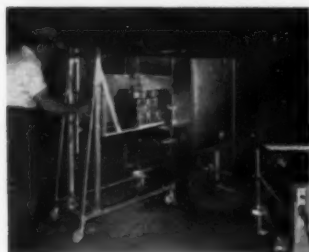
#### NEW ILLUSTRATED CATALOG

Send today for 28-page catalog, covering all Riehle Screw Power Universals. Contains illustrations, features, operating details, specifications.

# Engineering Digest

## OF NEW PRODUCTS

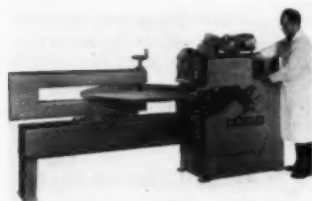
**FURNACE LOADER:** A new mechanical furnace loader developed by A. D. Alpine, Inc., speeds loading and unloading operations in heat treatment by eliminating single piece handling. All work to be treated is placed on the frame of the loader, which will handle several layers of work at one time, and the entire load picked up and inserted into the furnace by the fork bars of the loader.



Similarly, unloading is accomplished by simply inserting the fork bars and withdrawing the load from the furnace. The entire load is then wheeled to the quench tank or the next operation, and by hydraulic release quenched or placed at any desired level. During the entire operation, the operator is protected from heat by a built-in metal shield.

For further information circle No. 401 on literature request card on p. 32B

**CIRCLE SHEAR AND FLANGER:** The Niagara Machine & Tool Works has just announced a new high-speed circle shear and flanger, especially designed for high production of discs and heads at minimum tool investment. It is of interest particularly to manufacturers of tanks, drums, boilers, hot water heaters, containers, metal furniture and many other sheet metal products. As a circle shear it



cuts at high speed circular discs or circular arcs of sheet metal up to 8-gage mild steel or 12-gage stainless steel. Discs from 8 to 58 in. in diameter are produced from square blanks. Discs as large as 75½ in. in diameter can be cut from octagonal blanks. As a flanger it turns at high speed smooth, high flanges up to 1½ in. deep from circular discs. Head diameters ranging from 18½ to 73½ in. are flanged with ease.

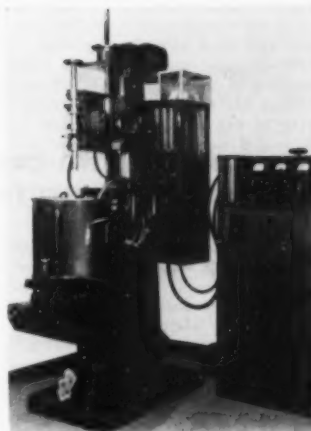
For further information circle No. 402 on literature request card on p. 32B

**MACHINING SINTERED CARBIDES AND SUPERALLOYS:** A completely new method of metal removal by direct utilization of electrical energy for machining any electrically conductive material has been developed. In the new process, known as Method X, metal is removed in a directed manner by means of an electric spark discharge which does not otherwise affect the work material's physical or chemical characteristics. The process is made available through the Method X Corp., an affiliate of the Firth Sterling Steel & Carbide Corp.

The machining action depends on a mechanical, not thermal, effect of electricity which sets up internal mechanical stresses by the use of extremely high current densities and thereby causes the metal particles to detach themselves from the work material without melting. Surface finishes of 26 micro-in. can be obtained. Lapping of less than 0.001 in. will produce any desired finish down to 0.15 micro-in. on sintered carbide. Center-to-center spacing of holes through the same workpiece can be controlled to approximately 0.0005 in. Blind hole fillet radii can be made as small as 0.002 in.

An example of application is for gas turbine blading. Blade root mounting serrations are being laboriously ground for the intricate shapes required and to extremely close tolerances. Blade sections are shaped by contour milling, precision casting or hammer forging. All processes are slow and expensive.

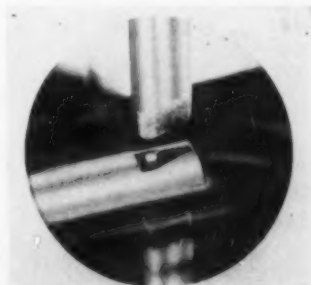
Die sections of sintered carbides are generally fastened by means of threaded steel sections brazed into the carbide and secured to the backing blocks by screws. Another means of



fastening die sections is to shape, drill and tap wedges to fix the carbide die sections to backing blocks. Both methods are slow and costly and not entirely satisfactory.

Gas turbine blade contours and root serrations can be readily shaped with Method X. Hardness has no effect on machinery speed. Sintered carbide die sections can be bored and tapped so that direct fastening to the backing blocks with machine screws can be accomplished. Complicated geometric shapes can be shaped directly into the hardest of metals.

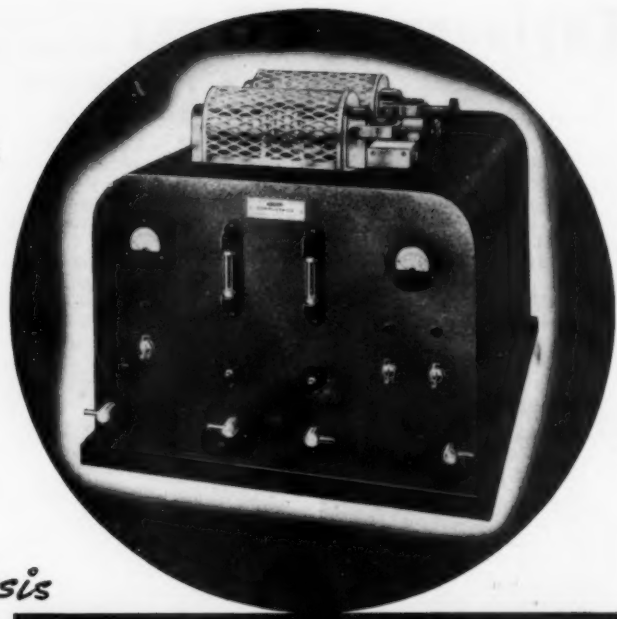
The problem of warpage encountered in heat treating steel dies composed of symmetrical hole shapes as in dies for electrical stator laminations can be eliminated completely by first heat treating the solid steel section and then machining the desired shapes by Method X.



The equivalent of all machining operations such as boring, drilling, tapping, internal and external shaping, engraving with a shaped electrode or by using the electrode as a cutting tool can be done expeditiously with Method X. In addition, some machining operations can be performed that are not practical even

**TWO TUBES . . . TWO CIRCUITS  
COMBUSTRON MODEL 120**

*by* **BURRELL**



*For carbon analysis  
in ferrous metals*

## **COMBUSTRON**

**ELECTRONIC INDUCTION HEATER**

### **TWO SEPARATE CIRCUITS PROVIDE TWO UNITS IN ONE**

Once again—Burrell has blazed a trail to greater value and service. With a Combustron, Model 120, users get two separate high frequency induction heaters built into one compact laboratory instrument. Operation of one circuit does not affect operation of the other in any way. Thus users get dual value—for heavy production or standby convenience.

Loading is horizontal for greatest flexibility. Combustion boats may be used for a great variety of samples ranging from coarse to fine meshes and low to high carbon content including alloy steel, cast iron and stainless steel. And—for analysis of low carbon steels, each Burrell combustion boat will take up to a full factor weight of coarse drillings.

Either Combustron model—two tube or one tube—provides rapid and accurate analysis of carbons-by-combustion.

Order direct from Burrell or Write for Bulletin No. 319.

#### **COMBUSTRON MODEL 120**

**Two Tubes—Two Circuits  
115 Volt—60 Cycle  
\$1100.00**

#### **COMBUSTRON MODEL 110**

**One Tube—One Circuit  
115 Volt—60 Cycle  
\$750.00**



**BURRELL**

**BURRELL CORPORATION • 2223 FIFTH AVE., PITTSBURGH 19, PA.**  
LABORATORY APPARATUS FOR SCIENTISTS EVERYWHERE

with ordinary machinable materials on conventional machines. For example, a blind triangular shape, open at the apex and having an integral pin located in the center of the triangle, is formed by the use of an electrode made to the shape desired and fed directly into the workpiece by the Method X machine.

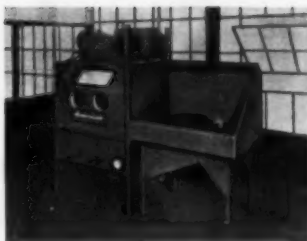
The machine's design is similar to a drill press with a pedestal-type base, an electrode feed and control mechanism, and a remote unit power supply fed from 220-volt, 60-cycle, single-phase lines. The peak demand under the most severe cutting conditions does not exceed 7 kw. A dielectric fluid such as fuel oil, kerosene or a compound especially developed for this purpose, Dielectro X, is used to enclose the cutting operation. The purpose of the work submersion in the Dielectro fluid is to build up electrical resistance so that the energy storage devices in the machine may be fully charged prior to discharge. Secondly, to flush the loosened particles from the work area.

Electrodes are made of a highly conductive, easily machined material such as brass, although other conducting materials may be used. They are usually machined to a negative of the shape to be produced when the machining operation can be performed with the head moving in a vertical direction.

**For further information circle No. 403 on literature request card on p. 32B**

**STEAM-JET CLEANER:** Livingstone Engineering Co. announces a new steam-jet cleaner Model JC-25. Heretofore, steam-jet cleaning has been found effective at steam pressures in the range from 125 to 145 psi, but field and laboratory tests have shown that faster cleaning can be obtained by stepping up the velocity of the jet without adding appreciably to the electric power requirements. The JC-25 is built to operate at pressures up to 200 psi. The combination of this high pressure and a new lance gives more powerful cleaning action. The JC-25 uses steam from a built-in high-pressure boiler. Small quantities of solvents are used effectively and economically. Rated at 20 kw., the JC-25 under ordinary operating conditions consumes 15 kw. per hr. **For further information circle No. 404 on literature request card on p. 32B**

**WET BLAST MACHINE:** The introduction of a new wet blast machine, the Liquamette, is announced by American Wheelabrator & Equipment Corp. Among the special features in



the new wet blaster is a vertical pump for slurry recirculation. It is adaptable to rugged service, and because of its position, it eliminates all suction piping, valves, fittings, and labor for removing them for inspection of the pump. It is always primed by flooded-type suction, and the operation of valves for starting or stopping is unnecessary. Loss of slurry through leakage is eliminated because there are no packing glands. Abrasive can't plug the pump impeller when the machine is shut down. Another important feature is that the hopper

need not be drained before the pump is removed. Rubber hose has been used instead of metal pipe wherever possible. A reset timer is available which tells at a glance the number of blasting hours that the abrasive has been in the machine. It lets the operator know when to change abrasive and makes it easier for him to avoid wasting abrasive. The machine is intended to perform work for which dry blasting is too severe; namely, work with thin edges and sharp corners or work needing precision cleaning. Abrasive sizes stocked range from 80 to 2500 mesh.

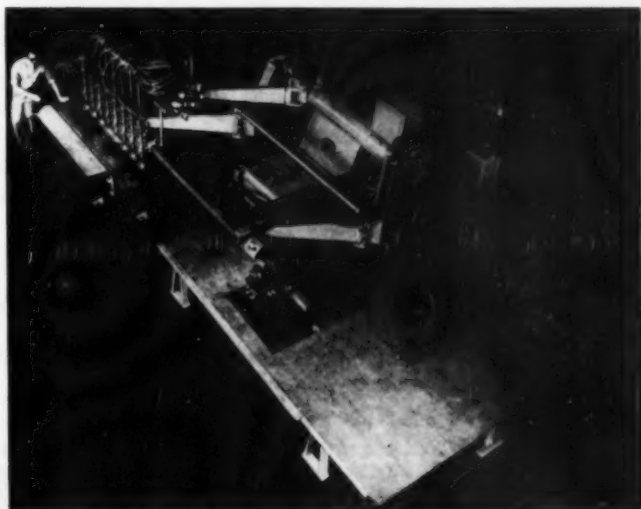
**For further information circle No. 405 on literature request card on p. 32B**

**TRAVELING HEAD GRINDER:** A new approach to the problem of face grinding is offered in the Series E-20 traveling head grinder, developed and built by Mercury Engineering Corp. Designed for the grinding of armor plate, it offers new opportunities in grinding edges, angular surfaces, compounds and bevels, as well as machin-

**GAS CUTTING MACHINE:** Air Reduction Sales Co. has announced the Airco No. 50 Travograph, the latest addition to its line of gas cutting machines. Guided by manual, magnetic or electronic tracer, this pantograph-type machine will cut an unlimited variety of shapes from steel plates, slabs, billets and forgings and makes equally practicable and economical the cutting of either one or a few parts or identical parts on a quantity

production basis. The rigid rail assembly, made of specially rolled tracks with accurately machined surfaces, provides a smooth runway for the carriage. Guide rollers on the carriage base keep the carriage on a true, vibration-free course. Flame hardened carriage wheels insure long service life. Torch holders are easily moved.

**For further information circle No. 406 on literature request card on p. 32B**



# Overcome Steel Shortage Reduce Costs



Fig. 1  
Meehanite Plate Bending Rolls

Fig. 2  
Plate Bending Machine

Fig. 3  
Uniformly covered  
by Brinell readings

**SPECIFY MEEHANITE CASTINGS**

The two Meehanite rolls shown, Fig. 1, have replaced forged rolls in a pyramid plate bending unit, Fig. 2. This is believed to be the first such installation.

Overall length of each roll is 14½ ft., diameter 13 inches. The rolls handle plate thicknesses up to 1¼ inches and 48 inches wide, imposing extremely unusual stresses on the journals and requiring high resistance to fatigue. They have been in daily service for over 18 months providing the toughness, strength and rigidity needed for this application.

Hardness and tensile tests were made from a 15" diameter riser used in pouring the casting, Fig. 3. Reading—241 Brinell across *entire* diameter; Tensile Strength 47,000 psi.

**SAVED** } STEEL FORGINGS (*always used previously*)  
6000 DOLLARS (*time—material*).

For information about how Meehanite Castings can improve your product, write—

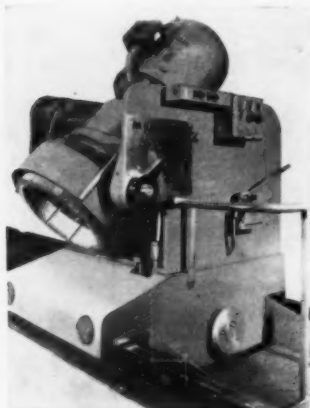
**MEEHANITE METAL CORPORATION**

HEARST SQUARE BUILDING • NEW BRUNSWICK, N.J. 08901





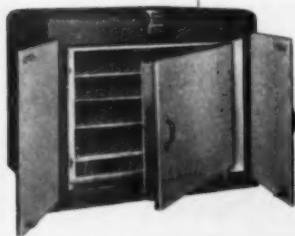
ing pads on heavy castings 20 ft. or longer. This grinder runs on self-powered precision rollers along rails machined to precision tolerances and equipped with built-in leveling devices.



The E-20, employing a 20-in. face-type grinding wheel mounted on a head which tilts from horizontal to full vertical, has complete mobility with traverse rate continuously variable. Two or more grinders can operate simultaneously on a single set of rails.

For further information circle No. 407 on literature request card on p. 32B

**PORTABLE ELECTRIC OVEN:** Announcement has been made by Grieve-Hendry Co. of a new low-priced portable electric oven, for processing at temperatures such as required for stress relief of springs and plated parts. Construction permits the nesting of one oven on top of another.



They can be used in groups or banks and can be operated individually, or selected ovens in the group can be cut out or heated at different temperatures. Temperature range is 100 to 800° F. Construction is heavy gage steel with Fibreglass insulation. It will operate from any 110-volt outlet.

No special wiring is required. 220-volt units are available. Thermostat, outside reading thermometer and pilot light are standard equipment. Size is 30 in. wide by 25 in. deep by 24 in. high, outside.

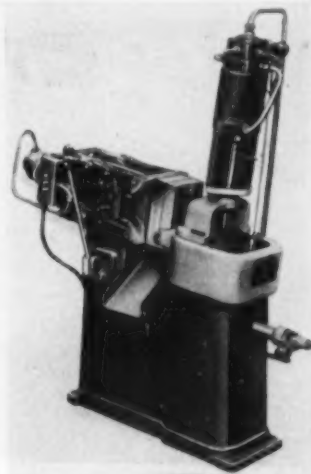
For further information circle No. 408 on literature request card on p. 32B

**STABILIZER FOR LOW-HYDROGEN ELECTRODES:** With the rapidly increasing use of the "low hydrogen" welding process, it has become necessary to find some means of protecting the electrodes from atmospheric moisture from the time they are removed from the moisture-proof container until they are put into use. A compact moisture-content stabilizer has been introduced by Fred C. Archer, Inc., which provides the desired protection of low-hydrogen welding rods at point of use. The unit stores 400 lb. of electrodes and, because of its size and design, may be located at any point convenient to the welding operation.

For further information circle No. 409 on literature request card on p. 32B

**DIE-CASTING:** A new 1-lb. die-casting machine, announced by DCMT Sales Corp., operates on a standard

80-psi. air line and consumes only 0.55 cu.ft. of free air per cycle of operation. Some of the specifications are as follows: pressure on metal with



1½-in. diameter plunger, 1620 lb.; die opening, 4 in.; casting capacity, 12 oz.; maximum area of casting, 12 sq.in.; standard diameter of plunger,

For quick, accurate, on-the-spot hardness testing, reading directly in the Rockwell scales.



## Ames PORTABLE HARDNESS TESTER

Flat and round bars, sheets, tubing and wire are tested on the spot without cutting off specimens. Punches, dies, cutters, saws and odd-shaped pieces are tested before and after heat treating. Used by metallurgists, inspectors and heat-treaters. Sizes for work 1" to 6" round and flat. Send for illustrated circular.

See Ames Tester demonstrated at Metals Show (Detroit) Booth A152

**AMES PRECISION MACHINE WORKS**  
Makers of Precision Bench Lathes & Milling Machines  
WALTHAM 54, MASSACHUSETTS



*At the Detroit Exposition—*

SEE THE  
GENUINE DAMASCUS  
STEEL BLADE

in our interesting panel "Tool Steels of the Past". This exhibit presents a selection of authentic swords and daggers made from tool steels several centuries ago.

- An additional display of modern tools, made from our First Quality high speed steels and die steels for hot and cold work, affords striking contrast to the work of the early steelsmiths. Our booth number is D-345—you'll be cordially welcome!

**Vanadium-Alloys**

STEEL COMPANY

LATROBE, PA.

COLONIAL STEEL DIVISION • ANCHOR DRAWN STEEL CO.

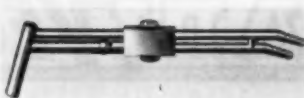
1½ in.; pot capacity, 45 lb. of zinc; floor space, 30 by 12 in.; weight (net), 450 lb.

For further information circle No. 410 on literature request card on p. 32B

**CUTTING TOOLS:** The new line of Superweld tools available from A. Milne & Co. features solid high speed steel heads of section equal to the tool shanks, joined to the shanks by electrical butt-welding. The heads are made of high speed steel containing 21% tungsten and 13% cobalt and are fully heat treated to give maximum cutting efficiency. The shanks are of medium carbon steel. The tools, as supplied, are ready to use; no forging or hardening is required.

For further information circle No. 411 on literature request card on p. 32B

**TORCH:** A built-in thumb control regulates gas and air volume on the new precision soldering-brazing torch manufactured by Mass Co. The new



torch works successfully either as a production tool or as a portable torch, for radiator, electrical and sheet metal work; also silver soldering, light brazing and hardening drills and drill bushings. The torch is 11½ in. long and weighs approximately 10 oz.

For further information circle No. 412 on literature request card on p. 32B

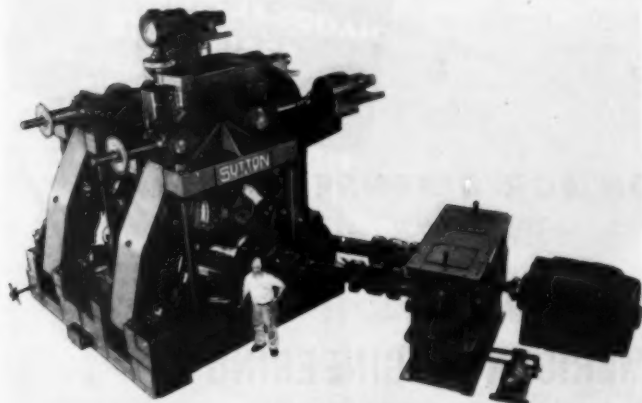
**PHOSPHATE TREATING COMPOUND:** A new phosphate compound for treating metallic parts is being produced by Octagon Process, Inc. It meets the specification for a Class C (Type II) finish in U. S. Army Spec. No. 57-O-2C and also JAN-C-490, Grade 1.

For further information circle No. 413 on literature request card on p. 32B

**TUBE AND BAR STRAIGHTENER:** The 5 M KTC bar and tube straightener by Sutton Engineering Co. is used for straightening tubes from 4½ to 16½ in. o.d. and solid bars from 4½ to 9 in. diameter. The design employs a total of seven straightening rolls. One group of three rolls is mounted at the entry end of the machine and another group of three at the delivery end. Each roll group is composed of one large driven roll and two idler rolls disposed at an angle of approximately 120° to each other. Located between the two 3-roll groups is a middle idler roll which

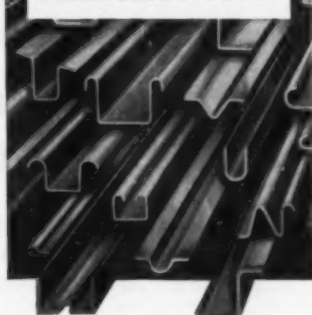
serves the purpose of deflecting the pipe during the straightening operation. This roll arrangement eliminates the use of all guides and at the same time positively confines the bar or tube to the pass line throughout the straightening operation. An outstanding feature of the KTC straightener is the automatic roll angling device. To change from straightening 5 in. to 14 in. tubes requires less than 2 min. Speeds vary from 60 to 240 ft. per min. using a 200-hp., 300 to 1200 rpm. adjustable speed d-c motor.

For further information circle No. 414 on literature request card on p. 32B



## COLD-ROLL FORMING

Up to 80%  
Saving in  
Material Cost



Of all the methods available for cold-shaping flat rolled metal, the cold-roll-forming machine offers the highest production per man hour and the lowest conversion cost. It is often a good investment even when operated only a few days per month.

Of still greater importance than conversion cost is often the saving of weight which may be effected by designing light, strong box, tubular and other special structural to take the place of hot rolled angles, channels, tees, etc. Material savings up to 50% are frequently made.

In press forming of hat shapes to make stator rings for jet engines, up to 80% of the metal has to be cut away and discarded in order to obtain one ring. By cold-roll-forming the profile from strip, cutting to length, bending into rings and joining ends, this huge scrap loss is avoided. Here is another example of how a Yoder Cold-Roll-Forming production line may save scarce and expensive stainless steel, aluminum, brass and other metals. In such cases, the material savings alone are usually many times greater than the conversion cost, even for relatively small quantities.

Function, scope and economics as well as mechanics of cold-roll-forming are discussed in Yoder's 86-page illustrated book which will be sent on request. Recommendations and estimates for the asking.

### THE YODER COMPANY

3595 Walworth Ave. • Cleveland 2, Ohio, U.S.A.

Cold-Roll  
FORMING  
MACHINES



# *Now* **SARCO RADIVECTOR**

FUEL-FIRED OR ELECTRIC

## HEAT TREATING FURNACES

FOR HARDENING, TEMPERING, ANNEALING, NORMALIZING,  
STRESS-RELIEVING, ALUMINUM TREATING, ETC., ETC.

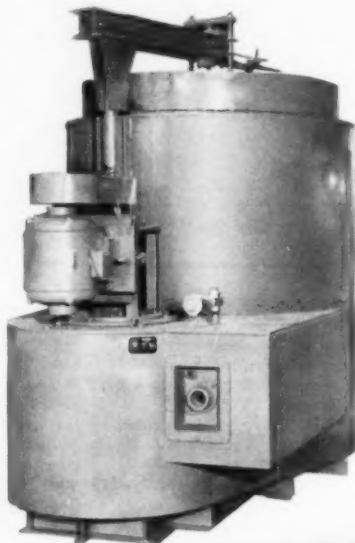
### NEW, FUNCTIONAL DESIGN PROVED PERFORMANCE

Field-tested for over 2 years, "RADIVECTOR" is an advanced heat treating furnace design incorporating both radiant and convection methods of heating.

The furnace load is preheated by radiation. This speeds *initial* heating, thereby shortening the cycle and increasing production.

Simultaneously, additional heat is transferred to the work by means of high velocity, pressure blower convection. 100% penetration of the work insures minimum temperature differential between top and bottom of the load *during* heating, and maintains uniformity at control temperature. This results in work of higher quality and minimizes the possibility of rejects caused by scale or distortion.

In the gas fired "RADIVECTOR" furnace, radiation and convection methods of heating are combined to such advantage that field tests prove 75% thermal efficiency at 1000° F. The increased production poundage obtained, per unit of fuel, results in both fuel conservation and lower fuel costs.



GET THE *INSIDE* STORY  
SEE OUR EXHIBIT AT THE  
NATIONAL METAL SHOW  
SPACE D-110  
OR WRITE FOR CATALOG AND  
TECHNICAL BULLETIN

*Higher*

**PRODUCTION FOR DEFENSE**

*at lower cost!*

**STANDARD AMERICAN ENGINEERING CO.**

7853 WEST 43RD STREET • LYONS, ILLINOIS

# What's New

## IN MANUFACTURERS' LITERATURE

### 415. Abrasive Belts

New catalog and basic manual on abrasive belt machines. Complete descriptions of each machine, as well as comprehensive data on a machining process especially adaptable to defense production. *Porter-Cable Machine Co.*

### 416. Abrasives, Coated

Six case histories on hand finishing operations for various parts and tools. *Behr-Manning Div.*

### 417. Alloy Brazing

New bulletin 20 covers silver alloy brazing with Easy-Flo and Sillos. Tells where and how to use these alloys to the best advantage. Shows many interesting applications; describes fast brazing techniques. *Hendy & Harman.*

### 418. Alloy Steel

Booklet on Curilloy steel tells how No. 4180 and others provide toughness, strength and lightweight durability under trying conditions of service. *U. S. Steel Co.*

### 419. Alloy Steels

New 16-page, pocket-size booklet entitled "Republic Alloy Steels and How to Get the Most Out of Them" contains seven case histories selected from widely varied fields to demonstrate the versatility of alloy steels. *Republic Steel Corp.*

### 420. Alloys, Fabricated

Catalog available showing cost-cutting fabricated heat treating equipment for higher payloads and better quality. *Relock, Inc.*

### 421. Alloys, Nickel

Hastelloy nickel-base alloys are available for fabricating corrosion-resistant screen, cloth and baskets. Also for metal spraying many types of automatic welding and hard-facing. Booklet, "Hastelloy Nickel-Base Alloys", gives full details. *Haynes Stellite Co.*

### 422. Aluminum

Copy of "Alcoa Aluminum Impact Extrusions" will be sent on request, giving full information on impact extrusion process and service. Shows whole range of shapes for engineering. *Aluminum Co. of America.*

### 423. Aluminum

16-page, 3-color booklet entitled, "Welcome to Jones Mills" shows how this plant produces aluminum pig by the electrolytic reduction process. *Reynolds Metals Co.*

### 424. Aluminum Castings

New 4-page two-color bulletin No. 20A describes facilities and methods for producing aluminum castings. *Aluminum Industries, Inc.*

### 425. Aluminum Forgings

To help you in designing for aluminum forgings, a new book is offered, covering relation of forging design to die sinking and relation of forging design to the manufacturing process. Also a section on metallurgy gives all commercial alloy compositions, physical properties and tolerances. *Aluminum Co. of America.*

### 426. Aluminum Welding

New control system, that extends electrode life for spot welding aluminum, fully described in "Technical Advisor No. 15". *Reynolds Metals Co.*

### 427. Barrel Finishing

55-page book on barrel finishing with Alundum tumbling abrasive. Procedures, practical operating suggestions, and characteristics of abrasive. *Norton Co.*

### 428. Belt, Abrasive

4-page, illustrated bulletin describes advantages of new "61" contact wheel. Time charts show how new, specially designed rubber wheel provides longer belt life and increased cutting rate. *Carborundum Co.*

### 429. Belts, Metal

Bulletin 47P illustrates and describes complete line of wire belts for industry. *Ashworth Brothers, Inc.*

### 430. Bending

32-page illustrated manual describes procedures for bending a wide variety of shapes from tubing, angles, channels, extrusions and other solid forms. *O'Neil-Irwin Mfg. Co.*

### 431. Beryllium Copper

Helpful engineering information contained in new monthly series of Beryllium copper technical bulletins. *Beryllium Corp.*

### 432. Bimetal Elements

64-page catalog written especially to help the design and product engineer select the type and size of thermostatic bimetal element best suited to his temperature-responsive device. *W. M. Chase Co.*

### 433. Blast Cleaning

Bulletin 32-B contains photographs and complete descriptions of AG blast cleaning cabinets for all types of industrial applications. *Karmelin Mfg. Co.*

### 434. Bottom Boards, Magnesium

Complete information and price schedule on magnesium bottom boards for maintaining high quality castings and mold stability. Available from stock in 74 standard sizes. *Christiansen Corp.*

### 435. Brass and Bronze

8-page illustrated booklet on control methods as applied to brass and bronze rod, forgings, die castings and welding. *Titan Metal Mfg. Co.*

### 436. Brazing Alloys

Standard pricing schedule and torch brazing instructions for silver brazing alloys listed in 4-page leaflet. *American Platinum Works.*

### 437. Brinell Tester

8-page bulletin on a portable Brinell hardness tester, employing 2.5, 5.0 and 10.0 mm. balls and loads from 187.5 to 1000 kg. *R. F. Farn Co., Inc.*

### 438. Bronze Alloys

New folder giving tables of properties (hardness, tensile, fabrication, physical) as well as use and forms and other data on Chase phosphor bronzes. *Chase Brass & Copper Co.*

### 439. Bronze Castings

Paper on effects of superheating, 85.5-5.5, 88.8-4 and 90-10 alloys, with tables and graphs showing physical property changes. *R. Lavin & Sons, Inc.*

### 440. Camera, High Speed

"Magnifying Time", a new folder describing high-speed camera capable of 1000 to 3000 pictures per second. Particularly adaptable for close inspection in machine tool operations and also for measuring flow of liquids as in chemical mixers, coolant flow, etc. *Eastman Kodak Co.*

### 441. Carbides

20-page "Aid to Carbide Users", in color, includes sections on standard and modified blank styles, solid ground cylinders, rectangular strips, standard bushings and solid carbide inserts. Catalog also features a grade selection guide. *Adams Carbide Corp.*

### 442. Carbon Control

Catalog T-623 describes the Microcarb control system that continuously measures the active carbon in the furnace atmosphere during heat treatment. *Leeds & Northrup Co.*

### 443. Carburizing

Interesting Char booklet tells how activated particles of Char are coated with a heavy shell of carbon, adding to mechanical strength and providing a protective coating. *Char Products Co.*

### 444. Castings

Bulletin FC-350 outlines the many advantages of improved Fabrite corrosion-resistant castings. *Ohio Steel Foundry Co.*

### 445. Castings, Steel

New bulletin describes PyraSteel, the chromium-nickel-silicon alloy for resisting oxidation and corrosion up to 2000°F and for withstanding most concentrated or dilute commercial acids and corrosive gases. *Chicago Steel Foundry Co.*

### 446. Cast Iron

48-page book, profusely illustrated, showing a wide range of light and medium castings produced in gray, alloyed and inoculated irons. *Hamilton Foundry & Machine Co.*

### 447. Cast Iron

4-page booklet providing case histories of unusual applications of Meehanite castings in various industries. *Meehanite Metal Corp.*



2000-3000° F.

Complete Assortment  
by **LINDBERG**

## LABORATORY FURNACES

Contact Boder Scientific Company, 719-721  
Liberty Ave., Pittsburgh 22, Pa. for detailed  
information, bulletins, and current prices.

**BODER**  
SCIENTIFIC  
PITTSBURGH



# Microcast<sup>®</sup>

## Power Blading Means Real Production Economies



Westinghouse Electric's J-34 Turbo-Jet Engine uses Microcast blades.

THE MICROCAST PROCESS of precision casting for aircraft engine power blading affords outstanding production economies to design engineers working on those remarkable new power systems. And the reasons for these savings over conventional methods are both unique and exclusive with the process. With Microcastings, you take advantage of the simplicity and inexpensiveness of tooling, avoid tool breakage. You effect sub-

stantial savings in expensive, critical alloys. Likewise, you effect manpower savings and free equipment and floor space for other necessary operations. Perhaps the Microcast Process can solve some of your production problems; better investigate today!

### FREE BOOKLET

on the precision process originated by Austenal Laboratories, Inc., for the production of castings of intricate design using the high melting point alloys where surface smoothness and dimensional uniformity are mandatory, requiring little or no machining. Write for booklet and information.



**MICROCAST DIVISION**  
AUSTENAL LABORATORIES, INC.  
224 East 39th St., New York 16, New York  
715 East 69th Place, Chicago 37, Illinois

# MICROCAST

MICROCAST TRADE MARK REG. U. S. PAT. OFF.

## What's New IN MANUFACTURERS' LITERATURE

### 448. Cast Monel

New bulletin contains valuable information concerning production of cast Monel and wide range of desirable physical and mechanical properties obtainable. *Cooper Alloy Foundry Co.*

### 449. Cleaning and Buffing

Bulletin 44 contains an interesting discussion of barrel deburring, as well as methods of removing many kinds of burrs from sawing, drilling, milling and stamping operations. *Magna Chemical Co.*

### 450. Cleaning and Finishing

Attractive 12-page, well-illustrated catalog A-652 gives the complete story on planning industrial finishing systems and shows many actual installations of cleaning and pickling machines operating in large metalworking plants. *R. C. Mahon Co.*

### 451. Cleaning Brushes

New booklet shows 12 actual case histories of how they provide thorough cleaning of welds, stainless sheet, hot cast iron, automotive parts, brass fixtures, and others. *Pittsburgh Plate Glass Co., Brush Div.*

### 452. Coatings, Metal

Explanations of high-vacuum evaporation of metals and other solids set forth in detail in new 12-page booklet, "Vaporized Metal Coatings by High Vacuum". *Distillation Products, Inc.*

### 453. Coatings and Packaging

New 43-page working data file provides valuable guide to better preservation and packaging with three sections on coatings, melting equipment and methods and processing procedures for "hot dip" packaging. *Seal-Test, Inc.*

### 454. Coatings, Zinc

16-page illustrated booklet discusses the origin of galvanizing, the various zinc coating methods employed today and the advantages of zinc as a protective coating for iron and steel products. *St. Joseph Lead Co.*

### 455. Control Instrument

Direct reading spectrometer described in bulletin 34 is calibrated and adjusted to the particular analytical need of each user. Analysis of as many as 12 elements read directly and simultaneously from clock dials. *Baird Associates, Inc.*

### 456. Continuous Sampling Monitor

New descriptive and illustrative tear sheet on electrical device which automatically keeps track of sampling procedure. *General Electric Co.*

### 457. Coolant-Lubricant

12-page bulletin on new coolant-lubricant for cutting, grinding, drawing and stamping. Includes three case histories and instructions for use. *General Aniline & Film Corp.*

### 458. Copper Alloy Forgings

12-page booklet provides practical, comparative illustrations on die-pressed copper alloy forgings. Contains tabulation of physical properties of copper and copper alloys suitable for forgings. *The American Brass Co.*

### 459. Copper Alloy Tubes

An extensively illustrated 32-page brochure, "Life Extension for Condenser Tubes", deals with causes of corrosion and means of combating them, as well as choice of materials for condenser tubes. *Revere Copper & Brass, Inc.*

### 460. Copper Alloys, Corrosion Resistance

24-page booklet, "Corrosion Resistance of Copper and Copper Alloys", explains the chemical and physical nature of corrosive attack. Includes tabulation indicating relative corrosion resistance of principal types of copper and copper alloys when in contact with 183 different corroding agents. *The American Brass Co.*

### 461. Corrosion Data

Wall chart of useful corrosion resistance information for several analyses of stainless steel tubing and pipe in contact with various corrosive agents. Reverse side contains mechanical data on tubing. *Carpenter Steel Co.*

### 462. Cupola Charging

Second of a series of booklets on better foundry operation entitled, "Tips on Improving Cupola Charging", contains valuable information on obtaining a smoother flow of materials from freight cars to cupolas. *Whiting Corp.*

#### 463. Cutting Oils

4-page folder on control of soluble oil coolant blending and reclaiming. *Bowser, Inc.*

#### 464. Degreaser

12-page illustrated bulletin describing operation of degreasing equipment and specific applications vapor degreasers, both tank-type and conveyor. *Phillips Mfg. Co.*

#### 465. Diamond Abrasive

New 4-page folder on Dymo-C, a diamond abrasive prepared especially for lapping and polishing carbide drawing and heading dies. Gives details on specific performance and application advantages. *Elgin National Watch Co.*

#### 466. Die Steel

New literature available on Bethlehem Co. Headed Die Steel for high production in forgings, bolts, rivets, screws, and other products at high speed. *Bethlehem Steel Co.*

#### 467. Electrodes, Hard-Facing

Bulletin announcing completely new line Wear-Arc hard-facing alloy electrodes. Includes full data on typical applications with physical properties, welding procedure and identification. *Alloy Rods Co.*

#### 468. Finishes

New 4-page, two-color bulletin describes detail the entire line of Iridite finishes for non-ferrous metals. Also includes section ARP process chemicals such as bright hardeners for zinc cadmium plating and other specialties. *All Research Products, Inc.*

#### 469. Finishing

Technical bulletin, designed as permanent folder, describes Aluminox, a new etching compound that eliminates cement-like scale formation on tank and coils. *Diversy Corp.*

#### 470. Forging

4-page folder, "Stainless and High Temperature Forging Alloys and Drop Forging Tolerance Data" furnishes the answers to questions on forging carbon, alloy and stainless steels and high temperature alloys. *Steel Improvement or Forge Co.*

#### 471. Forging Machines

Bulletin available describing Acme XN Forging Machines, featuring the exclusive toggle link construction. Specify size in ordering bulletin covering your own plant operation. *Hill-Acme*

#### 472. Furnace Controls

New 28-page condensed catalog 51-1 on turn-on and oven controls lists prices and illustrates variety of instruments such as temperature controllers, recorders and indicators, control valves. *Minneapolis-Honeywell, Industrial Div.*

#### 473. Furnaces

Catalog A-3 illustrates three specially constructed furnaces for versatile, economical heat treating of small and large tools and a vertical model for drills, reamers, broaches, etc. *Sentry*

#### 474. Furnaces

Literature describing the use of Marshall tubular furnaces for constant and uniform temperature furnished in types suitable to your needs. A radial brackets in stationary and compensating types. *Marshall Products Co.*

#### 475. Furnaces

New all-purpose furnace described in bulletin HD-646 may be used for carburizing, nitriding, dry cyaniding, bright annealing and clean hardening. *Hest Duty Electric Co.*

#### 476. Furnaces

Descriptive bulletins on salt pot furnaces in wide range of sizes for either high or low-pressure gas in heat treating small parts with salt bath processes. *Eclipse Fuel Engineering Co.*

#### 477. Gas Cutting Machine

New catalog available on Arco No. 50 Trace graph gas cutting machine, equipped with the distinctly different device—manual, automatic, or full-automatic Electronic Bloodhound cut most intricate shapes from only an outline drawing. *Air Reduction Sales Co.*

#### 478. Graphite Heat Exchange

Reprint available on Graphite Heat Exchanger Made of Kynar impervious graphite, these exchangers are used as boilers, coolers, condensers, vaporizers and absorbers in handling corrosive chemicals and can be ordered in complete size range. *National Carbon Co.*

#### 479. Hardness Numbers

Pocket-size table of Brinell hardness numbers incorporating other tabular information of importance to the metallurgist, inspector and engineer. *Steel City Testing Machines, Inc.*

#### 480. Heat Control

Bulletin 4257 describes Pyrocon for quick accurate reading of surface temperatures of molten revolving rolls, bearings and other materials. Also outlines a wide selection of thermocouples, extension arms for laboratory service. *Illinois Testing Labs.*

#### 481. Heating for Brazing and Annealing

8-page illustrated bulletin on high speed heat equipment for brazing, flame annealing, flame hardening, selective heating, and heating for forging. *Gas Appliance Service, Inc.*

# CROOKED CONTROL?



Visit the Wheelco Booth  
#D-219, National Metal  
Exposition and Con-  
gress, Detroit, Michigan,  
October 15-19.

## IT PAYS TO "GO STRAIGHT" WITH WHEELCO CAPACILINE

Get "straight-line" temperature control. This simple, low cost, supplementary control device adds the equivalent of proportioning control to your present pyrometer controller. Ideal for use on any kind of heating equipment such as ovens, furnaces, kilns, etc. Saves fuel — eliminates spoilage — prevents "over-and-undershooting" — insures continuous uniformity of

heat treated materials.

Use the Capaciline with "on-off" controllers of any make. There are no tubes, cams or motors in the Capaciline — it is operated through a very simple electrical circuit. The Capaciline is available as a small self-contained unit, or as a built-in feature of Wheelco's Capacilog strip chart recorders or Capacitol indicating controllers.

#### WHEELCO INSTRUMENTS COMPANY

835 West Harrison Street, Chicago 7, Illinois

Please send me Bulletin CL-1 on the Wheelco Capaciline.

Name \_\_\_\_\_ Title \_\_\_\_\_

Company \_\_\_\_\_ Street \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

# Micro Power Blading Real Production



Westinghouse Electric's J-34 Turbo-Jet Engine uses Microcast blades.

THE MICROCAST PROCESS of precision casting for aircraft engine power blading affords outstanding production economies to design engineers working on those remarkable new power systems. And the reasons for these savings over conventional methods are both unique and exclusive with the process. With Microcastings, you take advantage of the simplicity and inexpensiveness of tooling, avoid tool breakage. You effect substantial

cal all power and flexible operation. Process ducts gate to

## FREE BOOKLET

on the precision process originated by Austenal Laboratories, Inc., for the production of castings of intricate design using the high melting point alloys where surface smoothness and dimensional uniformity are mandatory, requiring little or no machining. Write for booklet and information.



MIC  
AUST  
224 Ea  
718 E



MICROCAST TRA

METAL PROGRESS; PAGE 32

## 463. Cutting Oils

4-page folder on control of soluble oil coolants, blending and reclaiming. *Bowser, Inc.*

## 464. Degreaser

12-page illustrated bulletin describing operation of degreasing equipment and specific applications of vapor degreasers, both tank-type and conveyorized. *Phillips Mfg. Co.*

## 465. Diamond Abrasive

New 4-page folder on Dymo-C, a diamond abrasive prepared especially for lapping and polishing carbide drawing and heading dies. Gives details on specific performance and application advantages. *Elgin National Watch Co.*

## 466. Die Steel

New literature available on Bethlehem Cold-Headed Die Steel for high production in forging bolts, rivets, screws, and other products at high speed. *Bethlehem Steel Co.*

## 467. Electrodes, Hard-Facing

Bulletin announcing completely new line of Wear-Arc hard-facing alloy electrodes. Includes full data on typical applications with physical properties, welding procedure and identification. *Alloy Rods Co.*

## 468. Finishes

New 4-page, two-color bulletin describes in detail the entire line of Iridite finishes for non-ferrous metals. Also includes section ARP process chemicals such as bright hardeners for zinc and cadmium plating and other specialties. *Allied Research Products, Inc.*

## 469. Finishing

Technical bulletin, designed as permanent file folder, describes Aluminux, a new etching compound that eliminates cement-like scale formation on tank and coils. *Diversey Corp.*

## 470. Forging

4-page folder, "Stainless and High Temperature Forging Alloys and Drop Forging Tolerance Data", furnishes the answers to questions on forging of carbon, alloy and stainless steels and high temperature alloys. *Steel Improvement & Forge Co.*

## 471. Forging Machines

Bulletins available describing Acme XN Forging Machines, featuring the exclusive toggle link construction. Specify size in ordering bulletin covering your own plant operation. *Hill-Acme Co.*

## 472. Furnace Controls

New 28-page condensed catalog 51-1 on turnace and oven controls lists prices and illustrates variety of instruments such as temperature controllers, recorders and indicators, control valves, etc. *Minneapolis-Honeywell, Industrial Div.*

## 473. Furnaces

Catalog A-3 illustrates three specially constructed furnaces for versatile, economical heat treating of small and large tools and a vertical model for drills, reamers, broaches, etc. *Sentry Co.*

## 474. Furnaces

Literature describing the use of Marshall tubular furnaces for constant and uniform temperature, furnished in types suitable to your needs. Also radial brackets in stationary and compensating types. *Marshall Products Co.*

## 475. Furnaces

New all-purpose furnace described in bulletin HD-646 may be used for carburizing, nitriding, dry cyaniding, bright annealing and clean hardening. *Hevi Duty Electric Co.*

## 476. Furnaces

Descriptive bulletins on salt pot furnaces in a wide range of sizes for either high or low-pressure gas in heat treating small parts with salt bath processes. *Edipax Fuel Engineering Co.*

## 477. Gas Cutting Machine

New catalog available on Arco No. 50 Travograph gas cutting machine, equipped with three distinctly different tracing devices—manual, magnetic, or full-automatic Electronic Bloodhound to cut most intricate shapes from only an on-line drawing. *Air Reduction Sales Co.*

## 478. Graphite Heat Exchangers

Reprint available on Graphite Heat Exchangers. Made of Karbate impervious graphite, these exchangers are used as boilers, coolers, condensers, vaporizers and absorbers in handling corrosive chemicals and can be ordered in complete size range. *National Carbon Co.*

## 479. Hardness Numbers

Pocket-size table of Brinell hardness numbers, incorporating other tubular information of importance to the metallurgist, inspector and engineer. *Steel City Testing Machines, Inc.*

## 480. Heat Control

Bulletin 4257 describes Pyrocon for quick, accurate reading of surface temperatures of molds, revolving rolls, bearings and other materials. Also outlines a wide selection of thermocouples and extension arms for laboratory service. *Illinois Testing Labs.*

## 481. Heating for Brazing and Annealing

8-page illustrated bulletin on high speed heating equipment for brazing, flame annealing, flame hardening, selective heating, and heating for forming. *Gas Appliance Service, Inc.*

## 482. Heating Elements, Electric

Bulletin H gives detailed information on AT-type nonmetallic electric heating elements, including tables for a wide variety of sizes available. *Globar Div., Carborundum Co.*

## 483. Heat Treating

Bulletin 120 tells how Niagara Aero Heat Exchangers provide better heat control in quenching bath, thus protecting physical properties and saving on water and piping equipment. *Niagara Blower Co.*

## 484. Heat Treating

Catalog 116 contains 72 pages of factual heat treating data for carburizing, cyanide hardening, brazing, austempering, and annealing processes. *Ajax Electric Co.*

## 485. Heat Treating

New 60-page book, "Houghton Defense Production Data" contains valuable metalworking "know-how" to help with all types of conversion problems. *E. F. Houghton & Co.*

## 486. Heat Treating

Handy, vest-pocket data book has 72 pages of charts, tables, diagrams and factual data on late steel specifications, heat treatments, etc. *Sunbeam Industrial Furnace Div.*

## 487. Heat Treating Equipment

Illustrated literature available on Heil impervious graphite "Norcordal" units. *Heil Process Equipment Corp.*

## 488. Heat Treating Furnaces

Information available on mechanized batch-type controlled atmosphere furnaces for gas cyaniding, gas carburizing, clean hardening or carbon restoration work. *One Furnace Co.*

## 489. Helical Springs

2-page on how to obtain economical assortment of 100 beryllium copper compression springs for development work. *Instrument Specialist Co., Inc.*

## 490. High Speed Steel

Bulletin SL-2036 describes the new, improved tungsten-molybdenum, high-speed steel, made especially abrasion resistant for taps, twist drills, milling cutters, lathe and planer tools. *Firth Sterling Steel & Carbide Corp.*

## 491. High Temperature

"Inco High Temperature Work Sheet" provides valuable information and suggestions for solving high temperature problems in design and production. *International Nickel Co.*

## 492. Immersion Heating

New folder N-33-6001 describes immersion thermocouple and Rayotubes for measuring bath temperatures in installations ranging from a 275-ton open-hearth down to a 1000-lb high-frequency induction furnace. *Leeds & Northrup Co.*

## 493. Induction Heater

Bulletin 319 describes the Combustion, electronic induction heater in two or one tube model for flexibility in analysis of low to high carbon content in alloy steel, cast iron and stainless steel. *Burrell Corp.*

## 494. Industrial Polishing

12-page booklet describing modern techniques of industrial polishing and buffing as related to the varied buffs, polishes and plating supplies. *Schaffner Mfg. Co.*

• If mailed from countries other than U.S.A., add amount of postage stamps required.

BUSINESS REPLY

No Postage Stamp Necessary If Mailed in U.S.A.

4c POSTAGE WILL BE PAID BY ADDRESSEE

METAL PROGRESS

7301

CL

#### 495. Industrial X-Ray

New catalog on "Industrial X-Ray Accessories" provides complete listing of this equipment, including chemicals, dark-room accessories, filing equipment, processing tanks, dryers and radiation instruments. *Picker X-Ray Corp.*

#### 496. Laboratory Furnaces

Information and bulletins available along with current price lists on complete assortment of Lindberg laboratory furnaces. *Boder Scientific Co.*

#### 497. Load Testing

Bulletin 325 describes new Type P SR-4 tension load cells based on SR-4 bonded resistance wire strain gages for load measurement. Gives specifications for load cells of four capacities between 10,000 and 100,000 pounds. *Baldwin-Lima-Hamilton Corp.*

#### 498. Magnesium

42-page booklet on processing and properties of wrought forms of magnesium. Includes 31 tables. *White Metal Rolling & Stamping Corp.*

#### 499. Metal Analysis

New brochure describes the operation of the ARL Production Control Quantometer which furnishes direct-reading, pen-and-ink records of quantitative spectrochemical analyses with extra copies, quickly and accurately. Up to 20 chemical elements measured simultaneously. *Applied Research Labs.*

#### 500. Metal Cleaner

New booklet, "Buffing Compound Removal Was a Tough Job", gives complete information on latest development in metal cleaning research. *Cosles Chemical Co.*

#### 501. Metal Cleaning

Information on new cleaning process that uses emulsion cleaners, based on petroleum and addition agent 230. This two-phase bath provides unique cleaning in conjunction with a thin displacement film that removes foreign particles. *Northwest Chemical Co.*

#### 502. Metal Cleaning

New booklet entitled "Your Metal Rearmament Products" contains outline of most efficient methods of handling, as well as cleaning, metal products for defense. *Alvey-Ferguson Co.*

#### 503. Metal Coating

Bulletin entitled "How To Obtain A Grade 1 Finish On Steel" furnishes full details on special protective coating required by Government Specification JAN-C-490. *American Chemical Paint Co.*

#### 504. Metal Finishing

New check list available on sixty products and processes for metal finishing, including a new acid addition agent, a cleaning and pickling agent combined, a new complete inhibitor and a new rust preventive compound. *Enthone, Inc.*

#### 505. Metallizing Process

New 20-page bulletin on the Mogal metallizing gun is fully illustrated and tells how this process aids in fighting corrosion rebuilding worn parts, and reclaiming mis-machined castings. *Metallizing Co. of America*

#### 506. Micrographic Equipment

6-page bulletin on a universal camera microscope giving plate magnifications from 4 to 3000X. Full details on optics and accessories included. *Optem Co.*

ies outside the United States, proper  
ps must be affixed for returning card

FIRST CLASS  
PERMIT No. 1595  
(Sec. 34.9 P.L. & R.)  
Cleveland, Ohio

REPLY CARD  
(If Mailed in the United States)

LL BE PAID BY—

ROGRESS

301 Euclid Avenue

CLEVELAND 3, OHIO



## PAST HISTORY!

THE NAVY ENLISTED BRANDT'S FACILITIES  
FOR "MOTHBALLS" ... AND BRANDT DELIVERED!

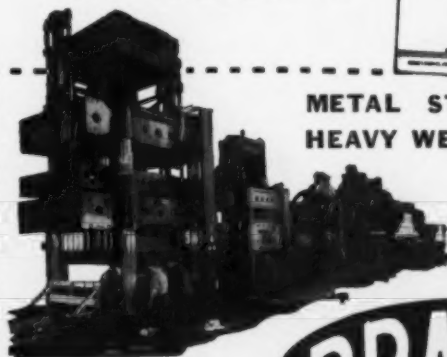


## NOW THE NAVY'S BACK AT BRANDT'S WITH HIGH-PRIORITY DEFENSE WORK!

As reported in September Reader's Digest, The Fleet's In—in good shape, thanks to the Navy's foresight. Brandt was a prime contractor in "Operation Mothball", the security investment that paid off. Now the Navy is back at Brandt's with new top-secret projects ... and Brandt will deliver!

Brandt's assembly lines are geared for mass production of prime and sub-contract defense work. Proximity to steel mills and rail and water transportation assures on-time delivery.

\*Regardless of stepped-up defense production, our industrial accounts still receive prime consideration.



METAL STAMPINGS  
HEAVY WELDMENTS  
PRESSED  
STEEL  
SHAPES

# BRANDT

BALTIMORE

CHARLES T. BRANDT, INC.  
1700 Ridgely St.  
BALTIMORE 30, MD.

# CROOKED CONTROL?

Visit the Wheelco Booth #D-219, National Metal Exposition and Congress, Detroit, Michigan, October 15-19.



## IT PAYS TO "GO STRAIGHT" WITH WHEELCO CAPACILINE

Get "straight-line" temperature control. This simple, low cost, supplementary control device adds the equivalent of proportioning control to your present pyrometer controller. Ideal for use on any kind of heating equipment such as ovens, furnaces, kilns, etc. Saves fuel — eliminates spoilage — prevents "over-and-undershooting" — insures continuous uniformity of

heat treated materials.

Use the Capaciline with "on-off" controllers of any make. There are no tubes, cams or motors in the Capaciline — it is operated through a very simple electrical circuit. The Capaciline is available as a small self-contained unit, or as a built-in feature of Wheelco's Capacilog strip chart recorders or Capacitrol indicating controllers.

**WHEELCO INSTRUMENTS COMPANY**  
835 West Harrison Street, Chicago 7, Illinois

Please send me Bulletin CL-1 on the Wheelco Capaciline.

Name \_\_\_\_\_ Title \_\_\_\_\_  
Company \_\_\_\_\_ Street \_\_\_\_\_  
City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

### 507. Microscopes

Well-illustrated 22-page catalog describes new line of laboratory microscopes featuring ball bearings and rollers throughout the focusing system and a low position fine adjustment, providing comfortable operation for high precision work. *Bausch & Lomb Optical Co.*

### 508. Ovens

Bulletin 4-T describes complete line of batch and conveyor-type ovens to meet every requirement in ferrous and nonferrous heat treating and also light alloys. *Young Brothers Co.*

### 509. Ovens, Furnaces

18 standard sizes of furnaces and ovens, oil, gas or electric; in batch or conveyor type for rapid, uniform heating in controlled temperature and atmosphere, described in bulletin 413. *W. S. Rockwell Co.*

### 510. Parts, Baskets

Baskets designed for your individual needs in handling parts. All types of trays, fixtures, retorts and carburizing boxes are described in catalog 16. *Stanwood Corp.*

### 511. Piping and Tubing

New 68-page book is a practical treatise on pipe and tube making, answering many pertinent questions on tube mill operations and production. *Foder Co.*

### 512. Potentiometer, Portable

Bulletins 270 and 270-A describe portable potentiometers in a selection of ranges up to 1.6 volts. *Rabicon Co.*

### 513. Precision Castings

4-page bulletin on precision investment casting in relation to product design. *Adapti Co.*

### 514. Press Loader

4-page, illustrated folder describes the Lodac automatic press loader with entirely new features for speed increase of presses on redraw operations. *Magnaflex Corp.*

### 515. Pressure Transmitters

Engineering data folders illustrate and describe complete line of pressure measurement transmitters. Folders include application data, available ranges, wiring and case diagrams. *Automatic Temperature Control Co., Inc.*

### 516. Pyrometer

Catalog No. 165 describes improved Pyro surface pyrometer. Eight instruments in one, it handles surface and sub-surface temperature measuring jobs. *Pyrometer Instrument Co.*

### 517. Pyrometer

New, general-purpose, low-temperature model, portable pyrometer now available as Type LT-840 Xactemp in a choice of four calibrations. *Clard S. Gordon Co.*

### 518. Radioisotopes

Booklet on use of isotopes as tracers in industrial research and testing. *United States Testing Co., Inc.*

### 519. Refractories

Revised bulletin entitled "Lumnite Refractory Concrete" discusses latest available information on refractories and heat-resistant concrete. *Lumnite Div., Universal Atlas Cement Co.*

**• If mailed from countries outside amount of postage stamps must be**

## METAL PROGRESS

7301 Euclid Avenue, Cleveland 3, Ohio

October, 1951

401	427	453	479	505	531
402	428	454	480	506	532
403	429	455	481	507	533
404	430	456	482	508	534
405	431	457	483	509	535
406	432	458	484	510	536
407	433	459	485	511	537
408	434	460	486	512	538
409	435	461	487	513	539
410	436	462	488	514	540
411	437	463	489	515	541
412	438	464	490	516	542
413	439	465	491	517	543
414	440	466	492	518	544
415	441	467	493	519	545
416	442	468	494	520	546
417	443	469	495	521	547
418	444	470	496	522	548
419	445	471	497	523	549
420	446	472	498	524	550
421	447	473	499	525	551
422	448	474	500	526	552
423	449	475	501	527	553
424	450	476	502	528	
425	451	477	503	529	
426	452	478	504	530	

Please have literature

Name \_\_\_\_\_

Company \_\_\_\_\_

Products Manufactured \_\_\_\_\_

Address \_\_\_\_\_

City and State \_\_\_\_\_

Postcard must be  
Students only



## 520. Refractory Mixes

Well-illustrated 16-page bulletin No. 315 provides important data on properties and applications of Sillimanite Super-Refractory ramming mixes and patches. *Chas. Taylor Sons Co.*

## 521. Rust Preventive

New "How" book shows how slushing and degreasing problems can be eliminated by Vapor-Wrapper method of packaging machines and parts. *Nox-Rust Chemical Corp.*

## 522. Rust Preventives

New literature available on Alox rust inhibitors for maximum protection of steel parts during fabrication, assembly, storage and shipment. *Alox Corp.*

## 523. Salt Baths

Technical data sheet available on Aeroheat 1200, a chloride mixture in granular form containing small amount of organic compound which acts as a rectifier and provides new solution to problem of decarburization. *American Cyanamid Co.*

## 524. Saws

Catalog 49 describes complete line of metal-cutting saws, covering 35 models in ten basic types, including fast, automatic production saw, hydraulic hack-saws and widely used small shop saws. *Armstrong-Blum Mfg. Co.*

## 525. Saws and Saw Blades

Extensive new catalog covering complete line of hand and power hack-saw blades, metal cutting hand saws, hand knives and other tools. *Capwell Mfg. Co.*

## 526. Soaking Pit

4-page technical bulletin with details on the construction and performance of new soaking pit which will reduce fuel consumption by 40% while almost doubling amount of steel heated. *Lofins Engineering Corp.*

## 527. Spectrophotometer

Bulletin B-211 illustrates junior-size spectrophotometer for identifying and measuring solution constituents in analytical or production laboratories. *Harshaw Chemical Co.*

## 528. Spot Welding

A convenient reference chart giving the recommended schedules for spot welding low-carbon steel. *Ampco Metal, Inc.*

## 529. Spring Wire

Detailed information on Pittsburgh oil tempered spring wire to help solve coiling, knotting, forming and twisting operation problems. *Pittsburgh Steel Co.*

## 530. Steam Drop Hammers

Profusely-illustrated 24-page brochure describes construction of steam drop hammers. *Erie Foundry Co.*

## 531. Steel, Alloy

New 24-page booklet, "How to Specify and Buy Alloy Steel with Confidence", emphasizes the importance of careful selection, positive knowledge of properties and accurate heat treatment in purchasing alloy steels. *Jos. F. Ryerson & Son, Inc.*

## 532. Steel Selector

Handy, clearly printed, easy-to-use tool steel selector will be furnished on request. *Crescent Steel Co. of America.*

## 533. Steels, Low-Alloy

Well-illustrated 8-page folder on N-A-X low-alloy steels lists physical properties and test specifications. *Great Lakes Steel Corp.*

## 534. Steels, Spring

Complete Spring Steel catalog offers 652 sizes of hardened and tempered spring steels, and in addition lists 133 cold-rolled and bright annealed sizes that are usually carried in stock. *Sandvik Steel, Inc.*

## 535. Steels, Tubing

Data card TDC 102 gives information on creep stress for tubing steels, and other technical data on operating equipment at elevated temperatures and pressures. *Babcock & Wilcox Tube Co.*

## 536. Super Refractories

New 20-page booklet gives technical information of a basic nature on super refractories. Text material is supplemented with charts, tables, illustrations and application data. *Carborundum Co., Refractories Div.*

## 537. Surface Hardening Compound

New illustrated 6-page folder on "Eutectic Instant Hardener" for emergency surface hardening with an ordinary welding torch. *Eutectic Welding Alloys Corp.*

## 538. Surface Inspection

8-page folder explaining applications and equipment for Faxfilm, a plastic-replica process to show roughness, wear, grain and other surface conditions. *Brush Development Co.*

## 539. Testing

New booklet describes ultrasonic Reflectoscope and tells how ultrasonic vibrations penetrate up to 30 feet to "see" internal defects and fatigue cracks in primary and finished metal parts. *Sperry Products, Inc.*

## 540. Testing

Folder on chemical, spectrographic, physical and metallographic services. *United States Testing Co., Inc.*

## 541. Testing Machine

New explanatory, descriptive and illustrative booklet on multi-load-range universal tester. *W. C. Dillon & Co., Inc.*

## 542. Thermocouples

Catalog 25H gives complete description of thermocouples designed for special and unusual requirements. *Thermo Electric Co.*

## 543. Thickness Tester

A bound reprint of N. G. Branson's documentary paper "Metal Wall Thickness Measurement from One Side by the Ultrasonic Method" plus an illustrated explanation of Audigage, Model FM SS-5 Thickness Tester. *Branson Instruments, Inc.*

## 544. Tool Steel

Selector is handy chart featuring general and heat treating data on non-deforming, water hardening, shock-resistant, hot work and high speed tool steels and hollow die steels. *A. Milne & Co.*

## 545. Tool Steels

Information on Warplas products, stock size and price folders will be sent on request, along with name of nearest distributor. *Pittsburgh Tool Steel Wire Co.*

## 546. Tool Steels

Full information on uses, compositions and heat treatment of carbon and carbon-vanadium tool steels. *Vanadium-Alloys Steel Co.*

## 547. Tubing

16-page illustrated catalog on electric welded steel tubing. Six pages of reference tables on steel tubing. *Nikoh Tube Co.*

## 548. Wear-Resistant Castings

New descriptive folder gives interesting facts on Colmonoy hard facing alloys, developed to combat different types of wear: abrasion, corrosion, impact, etc. Made in various forms to suit the methods of application. *Wall Colmonoy Corp.*

## 549. Welding, Scrap

Information available on oxygen-cutting and powder-cutting with Oxcord equipment to rapidly convert any steel or cast iron section into good, usable scrap. *Linde Air Products Co.*

## 550. Weld Rod, Hard Facing

4-page bulletin on applications for hard surfacing welding electrodes of 13 1/2% manganese-nickel steel. *Stolz-Stichels Co.*

## 551. Wire Cloth

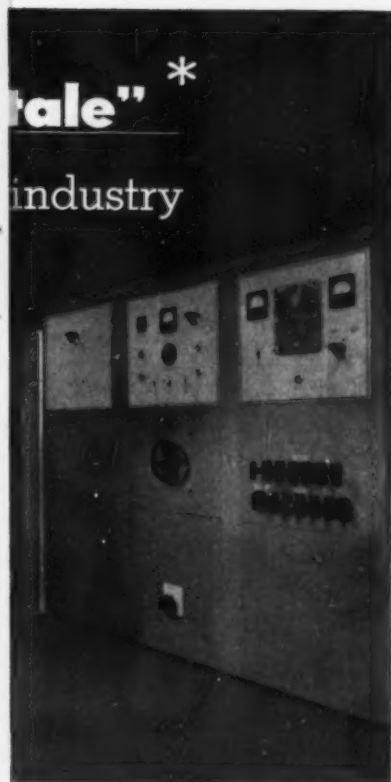
New manual entitled "Engineers Manual of Wire Cloth Strainer Design" describes selection of the grade of wire cloth and type of metal. *Michigan Wire Cloth Co.*

## 552. X-Ray Diffraction

Bulletin 304 describes the Hilger X-ray diffraction unit for determining internal strain or distortion, types of alloy formation, grain size and effect of heat treatment to establish correct annealing technique. *Jarrell-Ash Co.*

## 553. Zinc Plating

Newly revised bulletin on the S-B process for producing zinc deposits satin bright to bright in color, and particularly receptive to conversion coatings such as Lusteron, Cronak, Iridite and Anosinc. *Bantson-VanWinkle-Manning Co.*



... in minute quantities of only .002% can now  
... two minutes. That's how fast a complete analysis  
... is recorded with the new Quantometer\*, a direct  
... in use at the Titan mills.

... ill to adapt and install the Quantometer for the  
... and for the control of production of brass mill  
... lding rod and wire, forgings and die castings).  
... nd accuracy, the Quantometer represents an out-  
... etallurgical control.

... al development will further insure maximum  
... processes where Titan Brass products are used.

... and Agencies  
... nicipal Cities  
... is • Forgings  
... elding Rods

... side the United States, proper  
... st be affixed for returning card ]

... literature circled at the left sent to me.

... anufactured

... ate

... must be mailed prior to January 1, 1952—  
... dents should write direct to manufacturers.

## 507. Microscopes

Well-illustrated 22-page catalog describes new line of laboratory microscopes featuring ball bearings and rollers throughout the focusing system and a low position fine adjustment, providing comfortable operation for high precision work. *Bausch & Lomb Optical Co.*

## 508. Ovens

Bulletin 4-T describes complete line of batch and conveyor-type ovens to meet every requirement in ferrous and nonferrous heat treating and also light alloys. *Young Brothers Co.*

## 509. Ovens, Furnaces

18 standard sizes of furnaces and ovens, oil, gas or electric; in batch or conveyor type for rapid, uniform heating in controlled temperature and atmosphere, described in bulletin 413. *W. S. Rockwell Co.*

## 510. Parts, Baskets

Baskets designed for your individual needs in handling parts. All types of trays, fixtures, retorts and carburizing boxes are described in catalog 16. *Stanwood Corp.*

## 511. Piping and Tubing

New 68-page book is a practical treatise on pipe and tube making, answering many pertinent questions on tube mill operations and production. *Voder Co.*

## 512. Potentiometer, Portable

Bulletins 270 and 270-A describe portable potentiometers in a selection of ranges up to 1.6 volts. *Rabicon Co.*

## 513. Precision Castings

4-page bulletin on precision investment casting in relation to product design. *Adapt Co.*

## 514. Press Loader

4-page, illustrated folder describes the Lodac automatic press loader with entirely new features for speed increase of presses on redraw operations. *Magnaflex Corp.*

## 515. Pressure Transmitters

Engineering data folders illustrate and describe complete line of pressure measurement transmitters. Folders include application data, available ranges, wiring and case diagrams. *Automatic Temperature Control Co., Inc.*

## 516. Pyrometer

Catalog No. 165 describes improved Pyro surface pyrometer. Eight instruments in one, it handles surface and sub-surface temperature measuring jobs. *Pyrometer Instrument Co.*

## 517. Pyrometer

New, general-purpose, low-temperature model, portable pyrometer now available as Type LT-840 Xactemp in a choice of four calibrations. *Claud S. Gordon Co.*

## 518. Radioisotopes

Booklet on use of isotopes as tracers in industrial research and testing. *United States Testing Co., Inc.*

## 519. Refractories

Revised bulletin entitled "Lumnite Refractory Concrete" discusses latest available information on refractories and heat-resistant concrete. *Lumnite Div., Universal Atlas Cement Co.*

## 520. Refractory Mixes

Well-illustrated 16-page bulletin No. 315 provides important data on properties and applications of Sillimanite Super-Refractory ramming mixes and patches. *Chas. Taylor Sons Co.*

## 521. Rust Preventive

New "How" book shows how slushing and degreasing problems can be eliminated by Vapor-Wrapping method of packaging machines and parts. *Non-Rust Chemical Corp.*

## 522. Rust Preventives

New literature available on Allox rust inhibitors for maximum protection of steel parts during fabrication, assembly, storage and shipment. *Allox Corp.*

## 523. Salt Baths

Technical data sheet available on Aeroheat 1200, a chloride mixture in granular form containing small amount of organic compound which acts as a rectifier and provides new solution to problem of decarburization. *American Cyanamid Co.*

## 524. Saws

Catalog 49 describes complete line of metal-cutting saws, covering 35 models in ten basic types, including fast, automatic production saw, hydraulic hack-saws and widely used small shop saws. *Armstrong-Blum Mfg. Co.*

## 525. Saws and Saw Blades

Extensive new catalog covering complete line of hand and power hack-saw blades, metal cutting hand saws, hand knives and other tools. *Capevelli Mfg. Co.*

## 526. Soaking Pit

4-page technical bulletin with details on the construction and performance of new soaking pit which will reduce fuel consumption by 40% while almost doubling amount of steel heated. *Lofthus Engineering Corp.*

## 527. Spectrophotometer

Bulletin B-211 illustrates junior-size spectrophotometer for identifying and measuring solution constituents in analytical or production laboratories. *Harshaw Chemical Co.*

## 528. Spot Welding

A convenient reference chart giving the recommended schedules for spot welding low-carbon steel. *Ampco Metal, Inc.*

## 529. Spring Wire

Detailed information on Pittsburgh oil tempered spring wire to help solve coiling, knotting, forming and twisting operation problems. *Pittsburgh Steel Co.*

## 530. Steam Drop Hammers

Profusely-illustrated 24-page brochure describes construction of steam drop hammers. *Erie Foundry Co.*

## 531. Steel, Alloy

New 24-page booklet, "How to Specify and Buy Alloy Steel with Confidence", emphasizes the importance of careful selection, positive knowledge of properties and accurate heat treatment in purchasing alloy steels. *Jos. T. Ryerson & Son, Inc.*

## 532. Steel Selector

Handy, clearly printed, easy-to-use tool steel selector will be furnished on request. *Crucible Steel Co. of America.*

## 533. Steels, Low-Alloy

Well-illustrated 8-page folder on N-A-X low-alloy steels lists physical properties and test specifications. *Great Lakes Steel Corp.*

## 534. Steels, Spring

Complete Spring Steel catalog offers 652 sizes of hardened and tempered spring steels, and in addition lists 133 cold-rolled and bright annealed sizes that are usually carried in stock. *Sandvik Steel, Inc.*

## 535. Steels, Tubing

Data card TDC 102 gives information on creep stress for tubing steels, and other technical data on operating equipment at elevated temperatures and pressures. *Babcock & Wilcox Tube Co.*

## 536. Super Refractories

New 20-page booklet gives technical information of a basic nature on super refractories. Text material is supplemented with charts, tables, illustrations and application data. *Carborundum Co., Refractories Div.*

## 537. Surface Hardening Compound

New illustrated 6-page folder on "Eutectic Instant Hardener" for emergency surface hardening with an ordinary welding torch. *Eutectic Welding Alloys Corp.*

## 538. Surface Inspection

8-page folder explaining applications and equipment for Faxfilm, a plastic-replica process to show roughness, wear, grain and other surface conditions. *Brush Development Co.*

## 539. Testing

New booklet describes ultrasonic Reflectoscope and tells how ultrasonic vibrations penetrate up to 30 feet to "see" internal defects and fatigue cracks in primary and finished metal parts. *Sperry Products, Inc.*

## 540. Testing

Folder on chemical, spectrographic, physical and metallographic services. *United States Testing Co., Inc.*

## 541. Testing Machine

New explanatory, descriptive and illustrative booklet on multi-low-range universal tester. *W. C. Dillon & Co., Inc.*

## 542. Thermocouples

Catalog 25H gives complete description of thermocouples designed for special and unusual requirements. *Thermo Electric Co.*

## 543. Thickness Tester

A bound reprint of N. G. Branson's documentary paper "Metal Wall Thickness Measurement from One Side by the Ultrasonic Method" plus an illustrated explanation of Audigage, model FM SS-5 Thickness Tester. *Branson Instruments, Inc.*

## 544. Tool Steel

Selector is handy chart featuring general and heat treating data on non-deforming, water hardening, shock-resistant, hot work and high speed tool steels and hollow die steels. *A. Milne & Co.*

## 545. Tool Steels

Information on Warplis products, stock size and price folders will be sent on request, along with name of nearest distributor. *Pittsburgh Tool Steel Wire Co.*

## 546. Tool Steels

Full information on uses, compositions and heat treatment of carbon and carbon-vanadium tool steels. *Vanadium-Alloys Steel Co.*

## 547. Tubing

36-page illustrated catalog on electric welded steel tubing. Six pages of reference tables on tubing. *Nikoh Tube Co.*

## 548. Wear-Resistant Castings

New descriptive folder gives interesting facts on Colmonoy hard facing alloys, developed to combat different types of wear: abrasion, corrosion, impact, etc. Made in various forms to suit the methods of application. *Wald Colmonoy Corp.*

## 549. Welding, Scrap

Information available on oxygen-cutting and powder-cutting with Oxweld equipment for converting any steel or cast iron section into good, usable scrap. *Linde Air Products Co.*

## 550. Weld Rod, Hard Facing

4-page bulletin on applications for hard surfacing welding electrodes of 13% manganese-nickel steel. *Stuhs-Sichels Co.*

## 551. Wire Cloth

New manual entitled "Engineers Manual of Wire Cloth Strainer Design" describes selection of the grade of wire cloth and type of metal. *Michigan Wire Cloth Co.*

## 552. X-Ray Diffraction

Bulletin 304 describes the Hilger X-ray diffraction unit for determining internal strain or distortion, types of alloy formation, grain sizes and effect of heat treatment to establish correct annealing technique. *Jarrell-Ash Co.*

## 553. Zinc Plating

Newly revised bulletin on the S-B process for producing zinc deposits satin bright to bright in color, and particularly receptive to conversion coatings such as Lusteron, Cronak, Iridite and Anozinc. *Hanson-VanWinkle-Manning Co.*

**• If mailed from countries outside the United States, proper amount of postage stamps must be affixed for returning card**

## METAL PROGRESS

7701 Euclid Avenue, Cleveland 3, Ohio

October, 1951

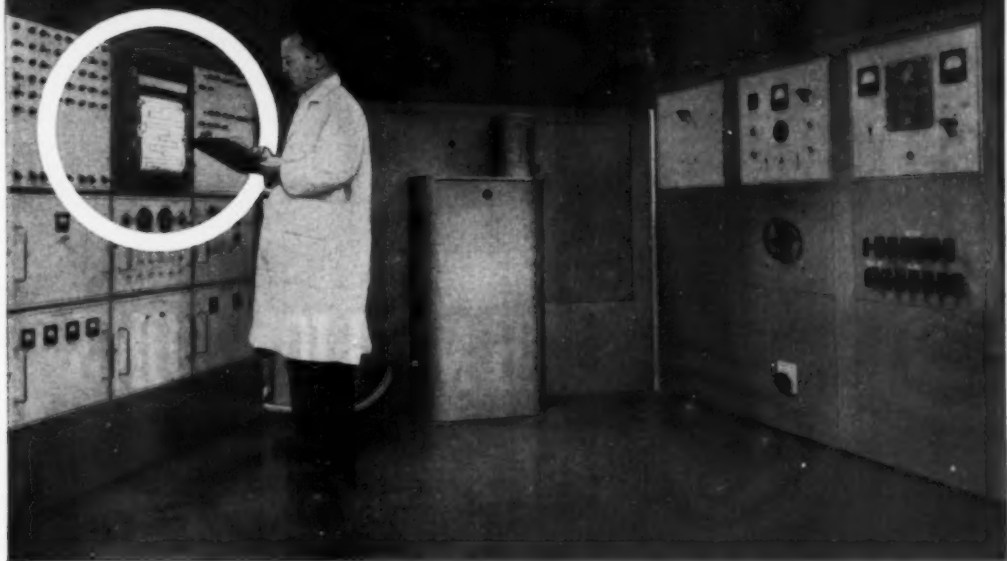
401	427	453	479	505	531
402	428	454	480	506	532
403	429	455	481	507	533
404	430	456	482	508	534
405	431	457	483	509	535
406	432	458	484	510	536
407	433	459	485	511	537
408	434	460	486	512	538
409	435	461	487	513	539
410	436	462	488	514	540
411	437	463	489	515	541
412	438	464	490	516	542
413	439	465	491	517	543
414	440	466	492	518	544
415	441	467	493	519	545
416	442	468	494	520	546
417	443	469	495	521	547
418	444	470	496	522	548
419	445	471	497	523	549
420	446	472	498	524	550
421	447	473	499	525	551
422	448	474	500	526	552
423	449	475	501	527	553
424	450	476	502	528	
425	451	477	503	529	
426	452	478	504	530	

Please have literature circled at the left sent to me.

Name	Title
Company	
Products Manufactured	
Address	
City and State	

Postcard must be mailed prior to January 1, 1952—  
Students should write direct to manufacturers.

the fastest **"tattle-tale"** \*  
in the brass industry



write for our new booklet:

**"Control—the Key  
to Improvement.  
in Quality Products"**

As many as eight elements in minute quantities of only .002% can now be analyzed accurately in two minutes. That's how fast a complete analysis of a brass or bronze alloy is recorded with the new Quantometer\*, a direct reading spectrometer now in use at the Titan mills.

Titan was the first brass mill to adapt and install the Quantometer for the selection of raw materials and for the control of production of brass mill products (rods, shapes, welding rod and wire, forgings and die castings). Because of its great speed and accuracy, the Quantometer represents an outstanding achievement in metallurgical control.

This milestone in industrial development will further insure maximum benefits to our customers' processes where Titan Brass products are used.



**Titan**

**METAL MANUFACTURING COMPANY**  
General Offices and Plants: BELLEFONTE, PA.

Offices and Agencies  
in Principal Cities

Quality Alloys by | Brass and Bronze Rods • Forgings  
Brass Specialists | • Die Castings • Welding Rods



It took 57,000 tons of steel to build the Empire State Building in New York. That's about one-tenth of one percent of the tonnage of scrap required to produce the new steel demanded for America's defense and civilian needs this year.

Half of this scrap is produced by the steel mills themselves. The other half - approximately 26 million tons - must be supplied by the public. That tremendous tonnage is the equivalent of 461 Empire State Buildings - over 1400 carloads of scrap every day of the year.

Right now there is a scrap shortage. It threatens to interfere with steel produc-

tion. So we appeal to you, as a user of steel and steel products, to do all you can personally to help collect scrap.

Somewhere in your place of business - and even at home - there are things that can be scrapped - worn-out or obsolete machines, pipe, boilers, tools, structural parts, etc., that you'll never use again in their present form. Turn them in through regular channels. Call the nearest dealer and start your scrap on its way to the steel mills - to help America reach its production goal of 105 million tons of new steel in 1951. It is this team-work that will help us win the victory again.



## The Youngstown Sheet and Tube Company

General Offices - Youngstown 1, Ohio

Export Offices - 500 Fifth Avenue, New York

MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

The steel industry is using all its resources to produce more steel, but it needs your help and needs it now. Turn in your scrap, through your regular sources, at the earliest possible moment.

# Inseparable

## EASY-FLO and SIL-FOS brazing

### Fast, low-cost metal joining

#### Just one example



Two girls easily braise 560 electrical transformer connectors per hour with the motorized turntable set-up below. They merely place and flux parts and EASY-FLO wire rings and remove finished assemblies. Brazing is done automatically as assemblies pass over the natural gas burners around half the table edge. It's as simple as that.



**AT THE METAL SHOW  
IN DETROIT—  
OCTOBER 15-19**

• SEE an actual production brazing job in action... See many examples of EASY-FLO and SIL-FOS brazed parts from both defense and domestic

production... Talk over your metal joining problems with our experienced engineers.

**BOOTH F-315**

In joining metals, you always want strong, lasting joints—and you want them in the fastest possible time with the least amount of labor, because that means low cost.

And that's precisely why you want to braze with EASY-FLO and SIL-FOS wherever and whenever you can—on defense production as well as domestic production. Fast, low-cost metal joining is inherent in the make-up and properties of these low temperature silver brazing alloys. In fact, with EASY-FLO and SIL-FOS you can reduce brazing to a simple push-button operation and get any metal joining output you need.

This is a proven fact. Thousands of manufacturers have done it on an amazing variety of ferrous, non-ferrous and dissimilar metal assemblies. All it takes is proper joint design and alloy application plus a little production-wise planning of the job.

#### A Brazing Expert is at your call

Without cost or obligation we'll send to your plant one of our experienced Field Service Engineers. He can tell you if, where and how you can use EASY-FLO and SIL-FOS to advantage. Be assured he will make no recommendation he cannot justify on the basis of better results for you. You can't lose by having him look over your metal joining work. Just contact our nearest office or agent and say when.

**24 PAGES OF USEFUL BRAZING FACTS  
IN BULLETIN 20. Write for a copy today.**



### HANDY & HARMAN



82 FULTON STREET • NEW YORK 38, N. Y.  
Bridgeport, Conn. • Chicago, Ill. • Los Angeles, Cal.  
Providence, R. I. • Toronto, Canada  
Agents in Principal Cities.





## "Hardware" for half-pint he-men by High Vacuum

THESE toy pistols are molded from clear polystyrene. Yet, after a session in a DPi high vacuum coating chamber, a .000005" thick film of aluminum makes them look more dramatically metallic to six-year-old eyes than the real thing.

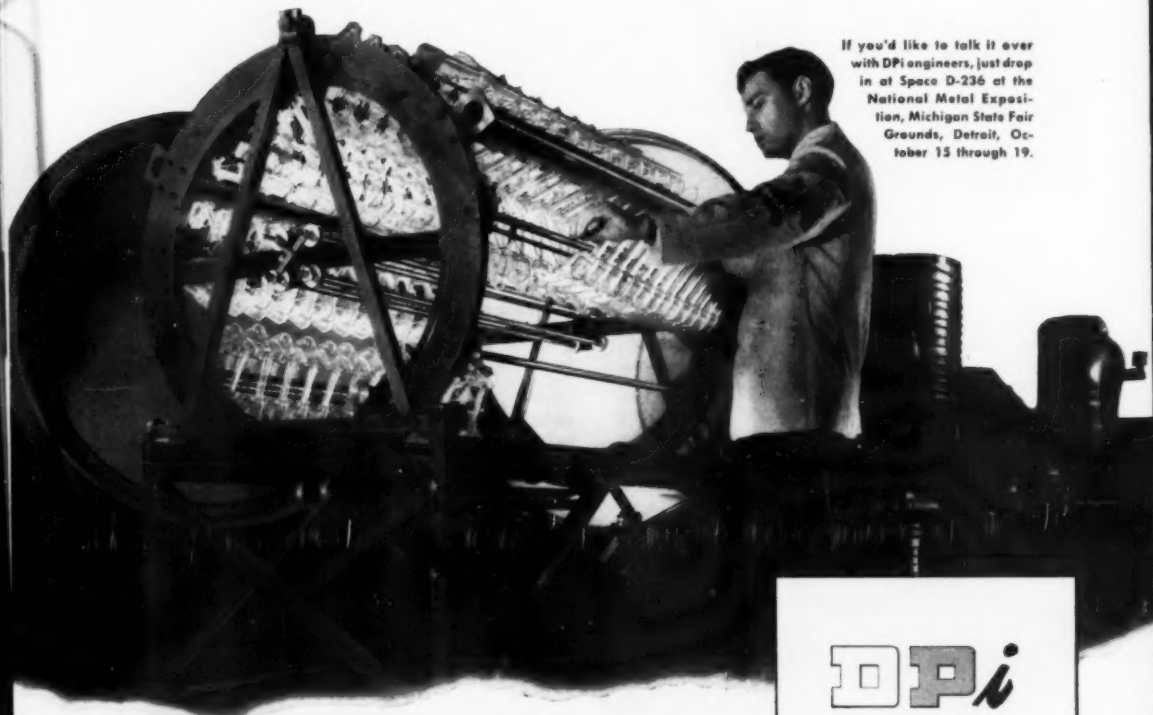
Real hardware is also being manufactured from various plastics in this way—items like doorknobs, where appearance counts heavily. High vacuum coating makes possible finishes never before seen on the hard-

ware market. It also keeps production lines moving for manufacturers of decorative hardware, by removing them from priority competition for scarce metals.

You'll also be hearing a lot soon about vacuum-depositing the most brilliant of metallic films on a specially lacquered base of inexpensive, abundant secondary metal—then protecting this finish with a highly durable transparent overcoat.

There is nothing mysterious about these new methods, even though

they result from research originally undertaken by DPi years ago for scientific applications. DPi has lived with them from their faint beginnings, and the experience of our engineers, both in vacuum technique and lacquering operations, is at your disposal to lead you into profitable production. Just write to *Distillation Products Industries*, Vacuum Equipment Department, 753 Ridge Road West, Rochester 3, New York (Division of Eastman Kodak Company).



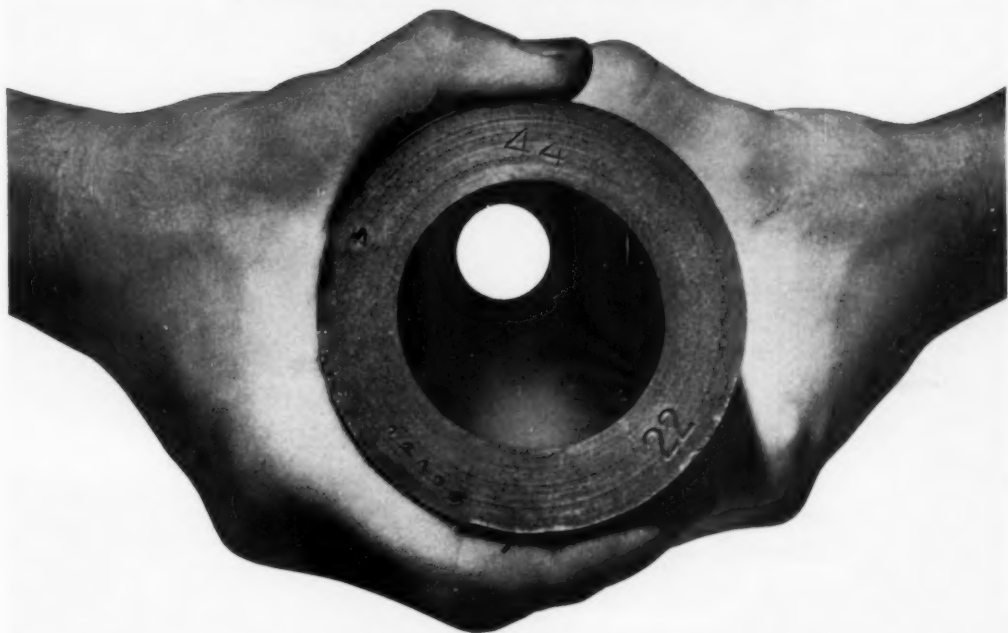
If you'd like to talk it over with DPi engineers, just drop in at Space D-236 at the National Metal Exposition, Michigan State Fair Grounds, Detroit, October 15 through 19.

**DPi**

**high vacuum research and engineering**

Also . . . vitamins A and E . . . distilled monoglycerides . . . more than 3400 Eastman Organic Chemicals for science and industry

## How to add machining capacity without adding machines



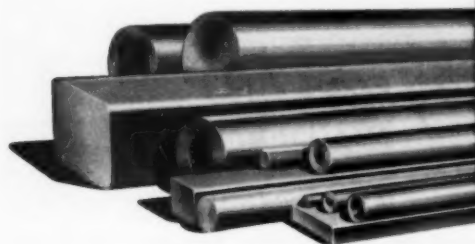
**Y**OUR machine tools become more productive when you use Timken® seamless tubing instead of bar stock for hollow cylindrical parts. Timken tubing has the center hole already there. Drilling is eliminated. Finished boring is often your first production step. As a result, screw machine stations are released for other operations.

You save steel, too, by using seamless tubing. Since the hole is already there, there's less metal that has to be machined away. You get more parts per ton of steel. And to further assure savings in material, the Timken Company

provides a tube engineering service which recommends the most economical tube size for your job—*guaranteed* to clean up.

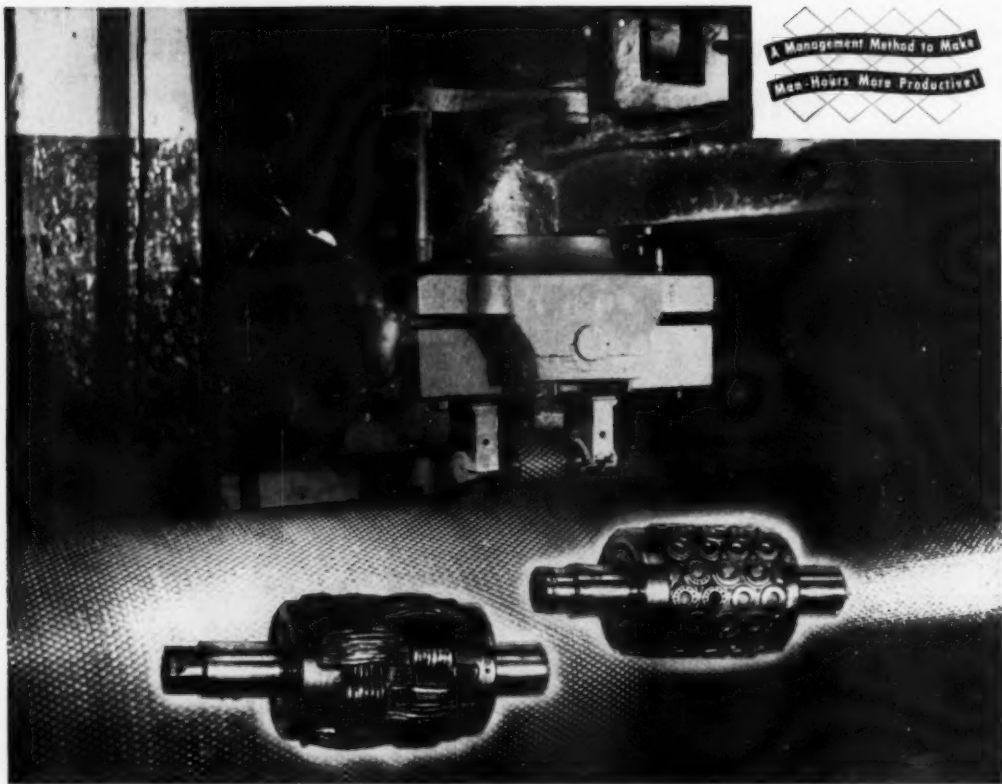
All this and better quality too! Because the piercing process by which Timken seamless tubing is made is basically a forging operation, you have fine forged quality in your product—greater strength and toughness. And from tube to tube and heat to heat, this quality is always uniform. It's rigidly checked at every step in production. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH



**TIMKEN**  
TRADE MARK REG. U.S. PAT. OFF.  
**Fine Alloy**  
**STEEL**  
**and Seamless Tubes**

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphite and standard tool analyses—and alloy and stainless seamless steel tubing.



A Management Method to Make  
Men-Hours More Productive!

## How to Put Delicate Patterns Through a 5-Ton "Wringer", Successfully



These knurling mills, made from No. 11 Special (Water-Hard) Tool Steel, press artistic patterns into large steel rolls for embossing cloth, paper and plastic. Here's what was required of the tool steel: It had to be hard enough to prevent upsetting; tough enough to prevent delicate edges from breaking under operating pressures up to 5 tons. Patterns on the mills were quite fragile and sections as deep as  $\frac{1}{16}$ " could not collapse. Further, the steel had to heat treat with very little warpage.

But picking the proper steel wasn't as

tough as you may imagine. For the Carpenter Matched Set Method not only indicated the one *best* steel for the job but enabled production management to "call its shots" . . . have the mills produce the required number of patterns on schedule, with less costly downtime.

For any plant making or using tools and dies, the Matched Set Method offers even

more advantages than simplified selection. You benefit from lower tool steel inventories, heat treating economies, simplified toolroom and production procedures. To discover how it can work for you in your plant, write for the new booklet "How to Get Better Tool and Die Performance". THE CARPENTER STEEL CO., 133 W. Bern St., Reading, Pa.

Export Department:  
The Carpenter Steel Company, Reading, Pa. "CARSTEELCO"

# Carpenter



**MATCHED TOOL & DIE STEELS**

**More than top-grade steels . . . a Method to keep tooling and production on schedule!**

For your convenience, Carpenter carries warehouse stocks in principal cities throughout the country

# "ROCKWELL" \* HARDNESS TESTERS

*See them in Action!*

at the  
**METAL SHOW**  
**in DETROIT**

•  
October 15 to 19  
•

**BOOTH**  
**A-342**

J-Model  
"ROCKWELL"  
HARDNESS  
TESTER



**TUKON TESTER**

◆ for ◆  
**MICROHARDNESS TESTING**

*See how easy it is to be sure  
of the hardness of metals you  
process — by using WILSON Hardness Testing equipment*

**ACCO**



# WILSON

**MECHANICAL INSTRUMENT DIVISION**  
**AMERICAN CHAIN & CABLE**

230-F Park Avenue, New York 17, N. Y.

**"ROCKWELL"  
HARDNESS  
TESTERS**

If your problem is abrasion, you'll be interested in this case history of Metal Mold centrifugally cast Ni-Hard pipe in action.

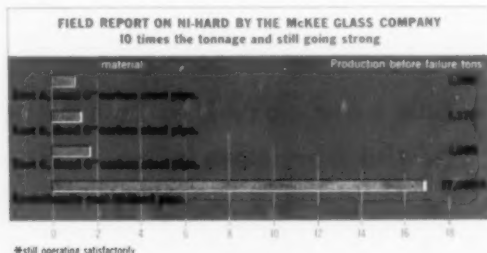
The McKee Glass Company, one of the nation's leading producers of molded glass for household and industry, uses a pneumatic conveyor system to handle its glass furnace charges. In this system tons of silica, sand, feldspar, borax, etc., are hurled at tornado-like speeds . . . about 100 miles per hour . . . through vacuum lines from boxcars to storage bins. Broken glass scrap (cullet) is added at the mixers to form a highly abrasive mixture.

Two years ago when the system was installed steel piping and later, lined steel piping was used. The severe abrasive action coupled with serious discoloration of the glass led to the search for a better conveying material. As a result, Metal Mold centrifugally cast plain end Ni-Hard pipe with a Brinnell hardness of 600-650 was

installed in the line's most abrasive sections.

The result, as reported by McKee, was more than satisfactory. Contamination was reduced 80%. Ni-Hard resisted abrasion much more effectively, as shown by the chart below . . . thus far, in fact, has carried *ten times the tonnage and the line is still going strong!*

Today, the McKee Glass Company uses Ni-Hard exclusively in its conveying system. Their experience may suggest the answer to *your* abrasion problem.



\*still operating satisfactorily.

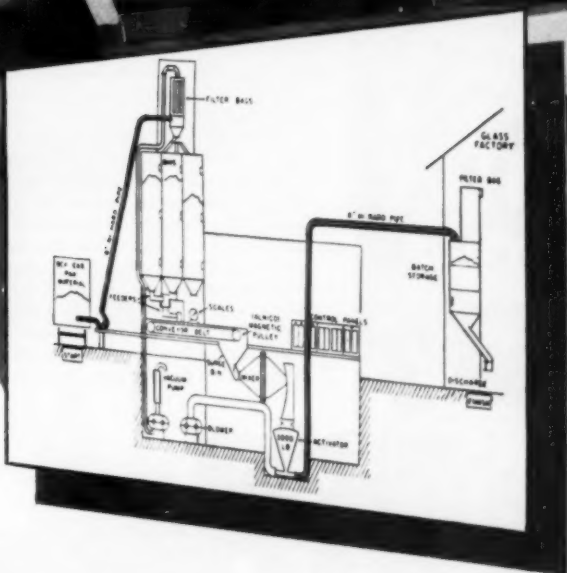
†Nickel-chromium white cast iron.  
Ni-Hard is a registered trade name of  
The International Nickel Co., Inc.



**U. S. PIPE AND  
SPECIAL PRODUCTS DIVISION**

**AMERICA'S LARGEST PRODUCER OF CENTRIFUGUALLY**





Flow Chart of McKee Glass Company raw material handling system in which Ni-Hard pipe is used to resist abrasive wear.

**FOUNDRY CO.**  
**BURLINGTON, N. J.**  
 CAST FERROUS METAL PRODUCTS IN TUBULAR FORM

#### TYPES OF METAL CAST

**Stainless Steel**—All AISI Types, plus special heat and corrosion resistant analyses.

**Alloy Steel**—all grades.

**Carbon Steel**—all grades.

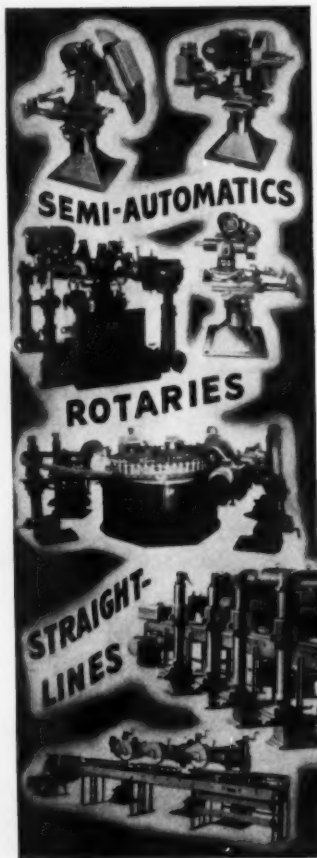
**Gray and Alloy Iron**—all standard and special analyses, including 4-Hard and Ni-Rodin.

**"Dual Metal"**—Gray or alloy iron inside steel, gray iron inside chilled iron and tool steel, iron or steel inside stainless, and many other metal-surgically bonded two-metal centrifugally cast combinations.

#### SIZE RANGE

Outside diameters—20" through 30". Wall Thickness— $\frac{1}{4}$ " to 4".  
 Lengths—Up to 14'.

# ACME *Automatic Polishing and Buffing Machines*



Which **ACME** Automatic  
will give YOU lowest cost  
production?

It depends . . . on the size, shape and material of the part you want to finish; on the production you require and on your plant space and layout. Acme Automatics include Straightlines, Indexing and Continuous Rotaries, with or without spindles, Semi Automatics and Special Machines. Each class of machine is built in a variety of types and sizes and may be equipped with varied special fixtures and accessory equipment to best meet the conditions involved in your specific job or jobs. Acme Automatics are versatile and their efficiency has been thoroughly proved in production for nearly half a century. Progressive Acme experience and established performance record in this specialized field is a substantial assurance of lower production cost and dependability under production operation in your plant.

**ROTARY  
STRAIGHT LINE  
SEMI-AUTOMATIC  
AND SPECIAL  
Polishing & Buffing  
Machinery**



CATALOGS ON REQUEST

**ACME Manufacturing Co.**

1400 E. 9 MILE RD., DETROIT 20 (Ferndale) MICH.

*Builders* OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR NEARLY HALF A CENTURY

**IN HEATING ...**



**IN MELTING ...**

Speed, control, and freedom from oxidation give you maximum output from every pound of metal you put into Ajax-Northrup heaters and furnaces.

Induction melting furnaces melt so fast there's no time for oxidation—losses of critical elements are held to a minimum. One user, melting stainless steel, reports recovery of 100% of the nickel charged, 99.0% of the chromium, 90% manganese, and 92% columbium. Another saved \$60,000 a year just by reducing chromium losses!

Forging heaters are equally thrifty. One automobile manufacturer reports ten tons of steel saved a day—enough for 3800 additional forgings. Savings up to 20% are commonplace, because fast, automatically timed induction heat eliminates steel-wasting scale and permits the use of smaller billets.

Ajax-Northrup melting furnaces are available in sizes from eight ounces to 8 tons, to melt any metal. Heaters for forging and other uses can be engineered to suit practically any of your high-speed production line jobs. Put our 35 years of experience with induction to work for you—write us today!

SEND FOR NEW INDUCTION HEATING AND MELTING BULLETIN.

**AJAX-NORTHTRUP**  
*Saves Metals*



**AJAX ELECTROTHERMIC CORPORATION**

**AJAX PARK • TRENTON 5, NEW JERSEY**

**AJAX**  
NORTHTRUP

**HEATING AND MELTING**

*Associate Companies*

AJAX ELECTRO METALLURGICAL CORP. • AJAX ELECTRIC COMPANY, INC.  
AJAX ELECTRIC FURNACE CORPORATION • AJAX ENGINEERING CORPORATION

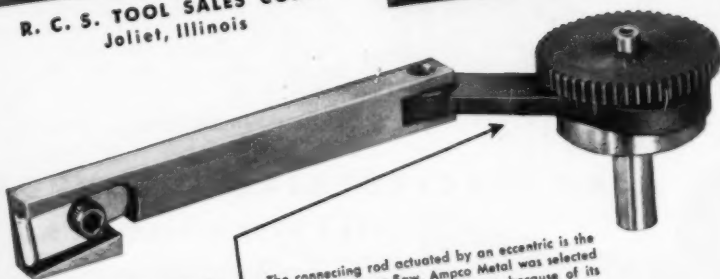
# FIGHT WEAR

...in both Product and Plant



New RSC Super Saw attachment for heavy-duty 1/4" electric drills provides an all-purpose, portable power-saw for cutting wood, sliding, "Insulbrick," "Ebonite," "Transite," fibre, Formica, galvanized sheet and other metals, cable, pipe, wire, nails, etc., — any shape: curves, angles, circles. No starting hole is needed.

**R. C. S. TOOL SALES CORP.**  
Joliet, Illinois



**APPLICATION:**

The connecting rod actuated by an eccentric is the heart of the Super Saw. Ampco Metal was selected as the ideal material for this part, because of its high strength and ability to resist wear.

**RESULT:**

The Super Saw can be used for continuous service, day in and day out.

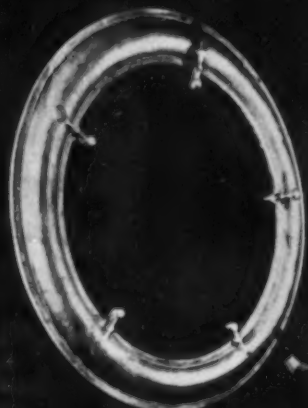
**IT'S PRODUCTION-WISE TO AMPCO-IZE!**



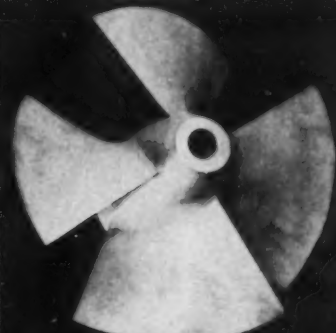
Gear blank — Centrifugally-cast



Centrifugal Casting



Ring — Sand-cast



Vanes — Sand-cast



Bushings — Centrifugally-cast Ampco Grade 18 standard bars.

# —with **AMPCO** **METAL**

You can save plenty of money and eliminate lots of trouble with high-strength Ampco Metal.

You see, Ampco Metal resists wear — such types of wear as erosion, abrasion and cavitation-erosion. It also resists corrosion. That's why so many designers are putting Ampco Metal to work in their products. They want longer part life, better performance.

Moreover, thanks to its various hardness ranges, Ampco Metal is ideal for a wide variety of product services and plant-maintenance jobs. It resists both wear and squashing out — stands up under the heaviest kind of service.

And Ampco Metal is easy to use. It's available in bars, sheet, plate, tubing, sand and centrifugal castings, forgings, wire and welding electrodes — practically any form you want. When extra performance life is needed both in manufactured products and in production, specify Ampco Metal. Consult your nearest Ampco field engineer or send coupon for further information.

\*Reg. U. S. Pat. Off., Ampco Metal, Inc.

*Tear out this coupon and mail today!*

**Ampco Metal, Inc.**

Milwaukee 46, Wisconsin



West Coast Plant  
Burbank, California

AMPCO METAL, INC., Dept. MP-10, Milwaukee 46, Wisconsin

Send me your free Ampco Metal literature giving descriptions and general applications of Ampco Metal.

Name.....Title.....

Company.....

Company Address.....

City.....(.....) State.....



**PLUMBING ENGINEERS ADVOCATE...**



**Brass  
Castings  
for  
Corrosion  
Resisting  
Qualities!**

FIVE THOUSAND YEARS of human experience is adequate testimony that Copper Alloys effectively resist the destructive forces of corrosion. Throughout the ages and especially today, Brass and Bronze Alloys coupled with skillful craftsmanship, consistently prove themselves best for plumbing installations. That is why . . .



**PLUMBING ENGINEERS ADVOCATE  
BRASS CASTINGS  
FOR CORROSION RESISTING QUALITIES!**



**R. LAVIN & SONS, INC.**

*Refiners of Brass, Bronze and Aluminum*

3426 SOUTH KEDZIE AVENUE · CHICAGO 23, ILLINOIS

REPRESENTATIVES IN PRINCIPAL CITIES

**RUST PREVENTION** CHEMICAL CORPORATION

SHEET NO. 25 FABU 2491 SOUTH HALSTED STREET • CHICAGO, ILLINOIS • PHONE 3-6100	NOX-RUST CHEMICALS ILLINOIS • PHONE 3-6100	PHYSICAL DESCRIPTION
MISCELLANEOUS DATA		PHYSICAL DESCRIPTION

Ask About  
**WEX-QUEST**

**SEND FOR THIS FREE CHART NOW**

OCTOBER 1951; PAGE 47

# ROLOCK

## FABRICATED

## ALLOYS

HEAT AND QUENCH  
RESISTANT

**SAVE SECONDS  
TO PREVENT SECONDS**



The design and construction of this Rolock engineered-to-the-job furnace basket is a practical example of heat and quench efficiency.

Vital seconds are saved thru operation of the two-piece center drop-bottom grid which dumps a dense load more uniformly than the usual one-piece grid with single hinge. It is foolproof...instant...rugged. The work hits the quench at practically its maximum temperature for uniform, high quality pit type furnace heat treating. Fabricated-welded construction and the use of a high nickel alloy

insure long service life, thus conserving scarce nickel.

Basket weight is 157 lbs.; load 1200 lbs.; a favorable high ratio of almost 8 to 1.

Rolock engineers welcome opportunities to solve tough material handling problems. Their assistance is yours on request.

• See our exhibit at the  
Metal Show, October 15-19  
Detroit, Mich., Building D,  
Booth D140.

Offices in: PHILADELPHIA • CLEVELAND • DETROIT • HOUSTON • INDIANAPOLIS • CHICAGO • ST. LOUIS • LOS ANGELES • MINNEAPOLIS

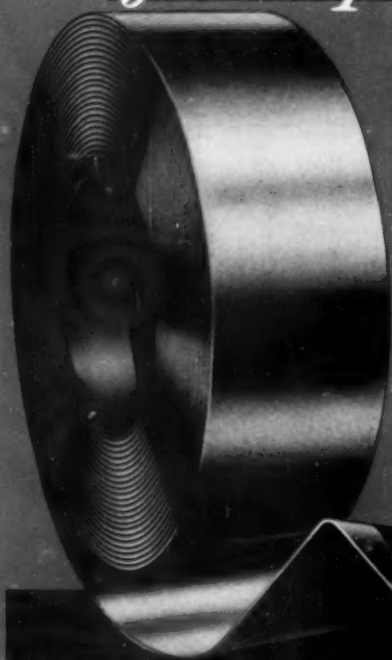
**ROLOCK INC. • 1222 KINGS HIGHWAY, FAIRFIELD, CONN.**

**JOB-ENGINEERED** for better work  
**Easier Operation, Lower Cost**

DALEY

**bright  
hard  
strong**

*for keeps!*



**Superior**

**Superior Steel**

CORPORATION

CARNEGIE, PENNSYLVANIA



gives your products these

*Superior* sales benefits

In your product planning for tomorrow, include SUPERIOR Stainless—for the sales appeal and fabricating dependability that will make future profits assured!

Superior Stainless Strip Steel improves product appearance, adds long life and easy maintenance—while providing handling qualities that are consistently uniform, thanks to always-precise dimensions and exactness of desired composition and temper.

*Let us send you technical data for your reference files.*

# Now you can select alloys for PERFORMANCE

*...and disregard fabrication difficulties*

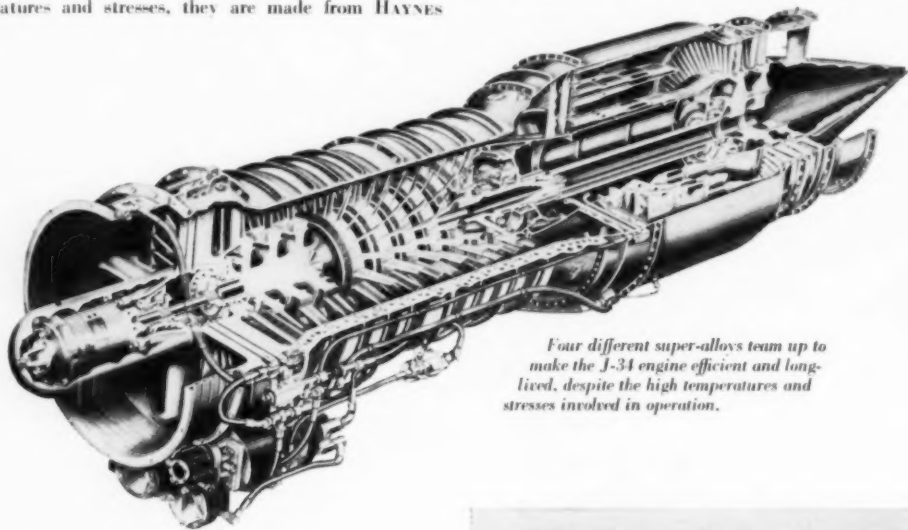
When HAYNES precision investment castings are specified, the only consideration necessary in choosing alloys is the service they will give in operation. Virtually any alloy can be cast accurately by this method—even the cobalt-base and nickel-base super-alloys.

The engineers who designed the J-34 turbojet engine took full advantage of this feature of precision castings. They selected four different alloys for the blades and vanes in this power plant—specifying the material best suited to each individual part. Because the blades in the turbine wheel are exposed to extremely high temperatures and stresses, they are made from HAYNES

STELLITE alloys Nos. 23 and 31. For the compressor vanes, which are subjected to slightly less severe conditions, Type 347 stainless steel is used. The turbine nozzle vanes are cast from a special alloy made to meet the manufacturer's requirements.

In addition to speeding the production of accurate aircraft parts, HAYNES precision castings have made possible marked savings in the production of machinery parts of all types.

See our display of precision castings and other HAYNES alloy products in area F-440 at the Metal Show in Detroit.



*Four different super-alloys team up to make the J-34 engine efficient and long-lived, despite the high temperatures and stresses involved in operation.*

**HAYNES**  
TRADE-MARK

*alloys*

## Haynes Stellite Company

A Division of  
Union Carbide and Carbon Corporation

**General Offices and Works, Kokomo, Indiana**  
**Sales Offices**

Chicago — Cleveland — Detroit — Houston  
Los Angeles — New York — San Francisco — Tulsa

"Haynes" and "Haynes Stellite" are trade-marks of Union Carbide and Carbon Corporation



# NEW SUPER QUENCH OIL...

... GIVES YOU TRIPLE ACTION!



1

## FASTER, DEEPER HARDENING

Mineral intensifiers give Park Triple A Oil faster quenching speed through the critical range, resulting in faster and deeper hardening.



2

## LESS DISTORTION

Fast, uniform hardening in the critical range, plus a low cooling rate through the temperature zone of martensite formation, means less distortion from Park Triple A Oil.



3

## BRIGHT QUENCHING

Special anti-oxidants used in Park Triple A Oil give it greater stability for longer life and bright quenching properties. This is important when work is quenched from carbo-nitriding furnaces.

Untouched photographs of precision parts quenched from a carbo-nitriding furnace in Park Triple A Quench Oil. From left to right are parts quenched the first day, 30 days later, 60 days later, and 90 days later. Bright and clean after over 3 months use with no indication of reduction of surface cleanliness.

For Hot Oil Quenching up to 450° F use Park Thermo Quench Oil. Send for Bulletin No. F-7.

### For These Critical Times...

Now more than ever you will need Park Triple A Quench Oil... with steels of critical hardenability due to lean alloy content and parts manufactured under government contracts, you can't afford costly rejects due to rigid inspection. Get the most from your quench oil — get Park Triple A Quench Oil today and save on critical material and expensive rejects. Send for Bulletin No. F-8 today, for complete information.



SEE US AT THE METAL SHOW—BOOTH F-456

HERE ARE 145 POSSIBLE CHANCES  
TO PUT YOUR FINGER ON IT —  
THERE ARE 322 MORE IN THE  
COMPLETE CATALOG.

[illegible]

Thicknesses  
from .020" to .024"

Thicknesses  
From .001" to .006"

**SANDVICH**

**It's yours for the asking. Use the coupon or drop a note on your letterhead.**

Band Saw Steels; Wood Band, Butcher Band and Metal Band • Steel for Textile Machine Parts • Camera Shutter Steel • Clock and Watch Spring Steels • Compressor Valve Steel • Doctor Blade Steel • Feeler Gauge Steel • Razor Blade Steel • Reed Steels • Shock Absorber Steel • Sinkers Steel • Spring Steels • Trowel Steel • Vibrator Reed Steel, etc.



City \_\_\_\_\_ State \_\_\_\_\_



111 EIGHTH AVE., N.Y. 11, WA 9-7180  
230 N. Michigan Ave., Chicago 1, FR 2-5638  
1736 Columbus Rd., Cleveland 13, OH 1-2383  
SANDWICH CANADIAN LTD.  
426 McGill St., Montreal, Can.

Here are the advantages of

# CHASE PHOSPHOR BRONZES

## HIGH STRENGTH



## HIGH-FATIGUE RESISTANCE



## GOOD DUCTILITY



## GREAT RESILIENCY



## EXCELLENT CORROSION RESISTANCE



**C**HASE PHOSPHOR BRONZES are hard working alloys that stand up under tough production assignments.

These tin-alloy bronzes are extremely versatile. You'll find one alloy suited for such functions as bearings, fuse clips, spring contacts and springs. Others will do a superior job in diaphragms, screw machine products, gears, spindles, valve parts and similar products.

Chase Phosphor Bronzes are made in Rod, Strip and Wire. Each is subject to the careful scrutiny of Chase metallurgists and engineers in order to maintain Chase standards for surface finish and the requisite internal characteristics.

Fill in and mail the coupon below for free folder giving further information about the properties of Chase Phosphor Bronzes.

**Chase**  **BRASS & COPPER**

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

• The Nation's Headquarters for Brass & Copper

Albany† Cleveland Kansas City, Mo. New York  
Atlanta Dallas Los Angeles Philadelphia  
Baltimore Denver Milwaukee Pittsburgh  
Boston Detroit Minneapolis Providence  
Chicago Houston† Newark Rochester†  
Cincinnati Indianapolis New Orleans St. Louis

San Francisco  
Seattle  
Waterbury  
(Trunks  
office only)



**FREE FOLDER**—Mail the coupon for folder giving tables of properties (hardness, tensile, fabrication, physical) as well as uses and forms.



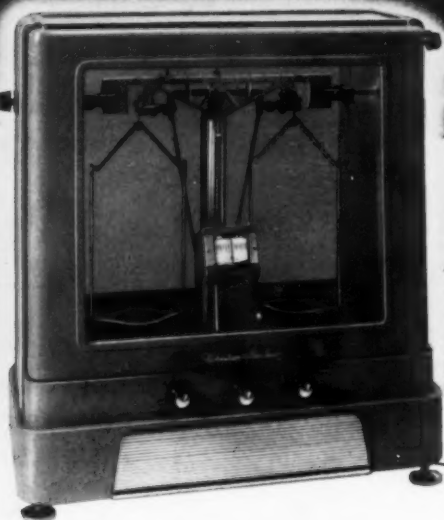
Chase Brass & Copper Co., Dept. MP1051  
Waterbury 20, Conn.

Please send me folder on Chase Phosphor Bronzes.

Name \_\_\_\_\_  
Firm \_\_\_\_\_  
Position \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ State \_\_\_\_\_

Speedy, Accurate Weighings • Improved Operation • Prolonged Sensitivity

with the new



## CHRISTIAN BECKER Projectomatic Analytical Balance

The newly designed Projectomatic balance makes possible automatic weighings from 1/10 mg to 100 mg, the results of which may be read on the magnified image of the scale which is projected onto a conveniently located screen.

In addition to the unique projection device, this balance features a new "floating" neoprene-cushioned black glass base plate to which no mechanism is mounted. With this arrangement breakage hazards are minimized, and a sturdy more rigid construction is achieved.

The model AB-1 is a double pan balance. Accordingly on a balance of this type it is possible to tare containers. Since it is recognized that in many weighing operations taring is an absolute necessity, a balance of the AB-1 type is desirable for most installations. In addition, this type of balance, although adapted for repetitive weighing, is ideal for routine laboratory work.

**H-1843—Christian Becker Projectomatic Analytical Balance . . . . . Each \$795.00**

### Specifications

**Capacity**—200 grams.

**Beam**—18.1 cm, of a special alloyed aluminum of great strength and uniform density. The beam is graduated left to right, 0 to 1 gram in 0.1 gram graduations (no weights below 1 gram required).

**Projection System**—the new Projectomatic makes possible automatic weighings from 1/10 mg to 100 mg. A vernier is provided for direct and positive reading to 0.1 mg. The zero of the screen is readily adjustable from outside the case.

**Knife Edges**—Agate. All knife edges are rigidly set in the beam.

**Bearings**—Agate Planes.

**Releasing Mechanism**—Beam Arrest. The special construction of the beam arrest insures the positive alignment of the agate edges with their respective bearings.

**Damper**—Magnetic damping arrests the oscillation of the beam almost immediately.

**Rider Carrier**—The enclosed vertical lift insures accurate alignment, in all positions, of lifting hook with the beam.

**Pans**—Stainless Steel, 2 $\frac{1}{8}$  in. diameter.

**Bows**—Brass, coated with a hard chemically resistant lacquer. Straight sides to accommodate large drying tubes, etc., 4 $\frac{1}{8}$  in. x 8 $\frac{1}{2}$  in. high.

**Pan Arrest**—The new independent pan arrest for pans with a positive stop.

**Vibration Dampers**—Special built-in dampers at each balance support dampen objectionable outside vibrations.

**Sash Balance**—The newly developed stainless sash balance for raising the front door eliminates the troublesome sash weights. The door opens wider, and more smoothly.

**Case**—18 $\frac{1}{4}$  in. x 9 in. x 20 in. high. Aluminum with glass top and front panel and a removable back panel. The newly designed sliding front door, which actually comprises a portion of the side of the case, eliminates the objectionable conventional front corner posts. The case exterior is finished in an attractive chemically resistant finish. The interior is white to brighten working area. Case provided with a drawer.

**HARSHAW SCIENTIFIC**  
DIVISION OF THE HARSHAW CHEMICAL CO.  
CLEVELAND 6, OHIO

Cleveland 6, Ohio  
1945 East 97th St.  
Cincinnati 2, Ohio  
224-226 Main St.  
Detroit 28, Mich.  
9240 Hubbell Ave.



Houston 11, Texas  
6622 Supply Row  
Los Angeles 17, Calif.  
3237 S. Garfield Ave.  
Philadelphia 48, Pa.  
Jackson & Swanson Sts.

# "Impressions that LAST"

FINKL MO-LYS-DIE Processed Die Blocks are made from steel developed by Finkl to answer the needs arising from drop forging problems. Their inherent toughness, resistance to heat checking and washing, high resistance to abrasion, and good machinability are the combinations that give you more forgings per impression and more impressions per die.

The MO-LYS-DIE trademark on a die block is a guarantee that the utmost care and attention have been given to forging, heat treating and testing operations. Learn for yourself—specify Finkl die blocks and get impressions that last.



## A. Finkl & Sons Co.

2011 SOUTHPORT AVENUE • CHICAGO 14

Eastern Warehouse  
INDUSTRIAL STEEL, INC.  
250 Bent Street, Cambridge 41, Mass.

Western Warehouse  
FINKL STEEL PRODS. OF CALIF.  
4908 Santa Monica Blvd., Los Angeles 27, Calif.

Detroit, Michigan • Cleveland, Ohio • Pittsburgh, Penna. • Louisville, Ky. • St. Paul, Minn. • Houston, Texas • Birmingham, Ala. • San Francisco, Calif.





## ROUND AND SHAPED TUBING

.010" to 1/2" O.D. Max.  
Certain Analyses .035"  
max. wall to 1 1/2" O.D.  
Available in:

### Carbon Steels:

A.I.S.I.—C-1008, MT-1010,  
MT-1015, C-1118, MT-1020,  
C-1025, C-1035, E-1095

### Alloy Steels:

A.I.S.I.—4130, 4132, 4140,  
4150, 8630, E-52100

### Stainless Steels:

A.I.S.I.—303, 304, 305,  
309, 310, 316, 317, 321,  
347, 403, 410, 420, 430,  
446, T-5

### Nickel Alloys:

Nickel, "D Nickel",  
"L Nickel", "Monel",  
"K Monel", "Inconel",  
30% Cupro Nickel,  
18% Nickel Silver.

Beryllium Copper.  
Reg. U. S. Trademark  
International Nickel Company

## Chapter 4

# Putting the Squeeze on Tubing —to End Bends!

Whether you use fine small tubing as a medium for transporting fluids or gases—or fabricate it into component parts—you want it straight as an arrow to start. That's where the machine pictured above comes in.

Commercial straightness is easily attained with Superior's numerous types of specialized straightening equipment.

In the normal course of tube drawing operations, unequal stresses are set up and the resultant tube has bends and bows which must be removed.

All these stresses are equalized in one operation. The tube is straightened and the end result is a better product for you.

To produce the world's best tubing we inspect and check many times, mechanically and metallographically. We use microscopes to detect structure, and keen-eyed inspectors to detect surface scratches, splits and pits. A continuing program keeps every Superior production worker aware of his part in the quality picture.

What does this mean to you?

It means you get fine small tubing that will do the toughest jobs better. Right now (because of Defense Orders and metal shortages) we may not be able to fill all of your tubing requirements, but it will pay you to check with your Superior distributor—he may have enough tubing in stock to help you. Always specify Superior Tubing and you'll always be right. Superior Tube Company, 20018 Germantown Ave., Norristown, Pa.  
West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. UNderbill 0-1331.

# Superior

THE BIG NAME IN SMALL TUBING

All analyses .010" to 1/2" O.D.  
Certain analyses (.035" max. wall)  
Up to 1 1/2" O.D.



Cleveland Photo — Aerial Surveys, Inc.

## the wheelco recorder

In Cleveland factories, whether it's tin cans or the food in the cans—delicate hair springs or giant gears—fine ceramic ware or sturdy milk bottles—colorful auto paint or engine oil—the Wheelco Recorder accurately writes a diverse production history. For invaluable assistance in your own plant, follow the lead of progressive production men—for measurement, indication, control and recording of electrically measurable variables, specify the economical Wheelco Capacilog, deflection type, strip chart recorder.

Yes, for accuracy to  $\frac{1}{4}$  of 1% of total scale, specify the Wheelco Capacilog. Capacilogs are built for use with thermocouples and re-

sistance thermometer measuring elements; as single or multipoint recorders, and with six different control combinations including pneumatic and electric proportioning types. Remember, in Cleveland and throughout the nation where production records are set, they're made and kept on Wheelco recorders.

**Assembly line production and simplicity of construction make it possible to deliver most models within 20 days.**



Visit the Wheelco Booth #D-219, National Metal Exposition & Congress, Detroit, Michigan, October 15-19  
Wheelco Instruments Company, 835 W. Harrison Street, Chicago 7, Illinois

**wheelco**  **electronic controls**

# HOW TO GET THE MOST OUT OF THE



"lean alloys  
do the job when  
we use U-S-S Improved  
Heat Treatment\*"

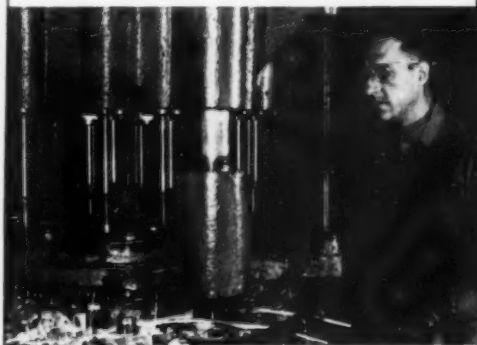
says C. E. WILDERMAN;

Vice President, Tool Division, Utica Drop Forge & Tool Corp., Utica, N. Y.

\*available without charge



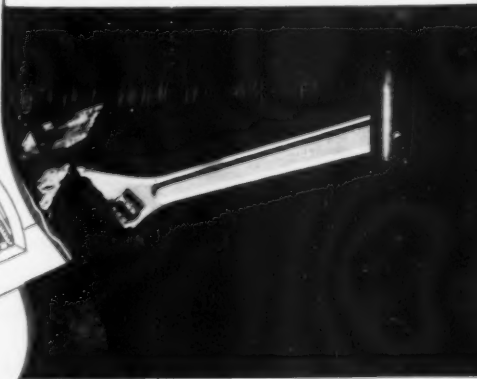
"... lean alloys forge easier than high alloys, so we get longer die life."



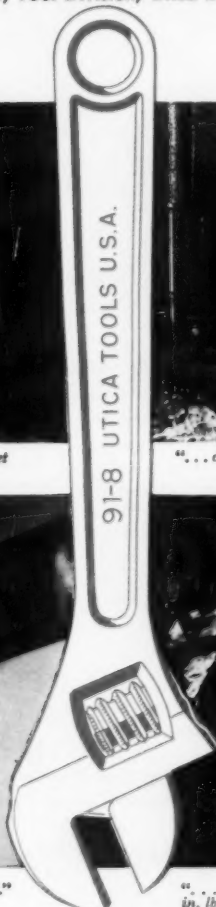
"... drilling and machining operations are simplified."



"... working faces are easily induction hardened."  
Notice dark sections on jaw faces.



"... torque tests average 25,000 in. lbs. against 7,650 in. lbs. required by Federal Specifications."



# LEAN ALLOY STEEL YOU'RE GETTING



U-S-S Improved Heat Treatment is an improved method of quenching and tempering by means of violent agitation of the quenching bath. The basic engineering principles involve quench tank design, and the definite size, number, placement and powering of the propellers.

BY USING U-S-S IMPROVED HEAT TREATMENT, the Utica Drop Forge & Tool Corp. find they easily achieve the great strength demanded in their high quality adjustable-end wrenches with a medium carbon lean alloy grade of Carilloy steel. The use of a lean alloy in turn means several extra advantages. But let Mr. Wilderman tell the story:

"We have 3 big reasons for using a lean alloy steel for our wrenches. 1) It forges easier than the high alloys, so we get longer die life, 2) Lean alloys require shorter annealing cycles and 3) Our drilling and machining operations are simplified and we have lower perishable tool cost.

"Using U-S-S Improved Heat Treatment, our metallurgists have developed heat treating methods that enable us to get results with lean alloys that are equal to or even better than those obtainable with the high alloys.

"In our operation, the wrench is hardened and tempered to a uniform 44/46 Rockwell "C" scale with the aid of U-S-S Improved Heat Treatment. Then the working faces are easily induction-hardened to 55/57 Rockwell "C" scale. The induction-hardened areas are shown by the dark sections on the photograph.

"Daily control tests conducted on the hydraulic

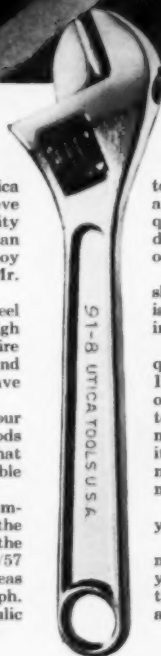
testing machine shows results (for the 12" wrench) averaging 25,000 in. lbs. against 7,650 in. lbs. required by Federal Specifications. We think a good deal of the credit for these torque ratings is due to our U-S-S Improved Heat Treatment."

If you are having heat treating difficulties, keep a sharp eye on *quenching* methods. Proper quenching is often just as important—sometimes even more important than the steel or the heating.

U-S-S Improved Heat Treatment is a superior quenching method developed by United States Steel. It removes heat quickly and evenly from every part of the material's surface. Elapsed time from quench to tempering treatment is held to an absolute minimum. This not only improves mechanical properties; it also reduces cracking. Furthermore, this quenching method improves machinability by minimizing formation of free ferrite in hypo-eutectoid steels.

The use of this quenching process is available to you without charge.

We do not manufacture or sell heat treating equipment, but our metallurgists will be glad to analyze your heat treating methods and make suggestions that may give you more uniform hardness, less rejects and less re-treatments.



UNITED STATES STEEL COMPANY, PITTSBURGH • COLUMBIA STEEL COMPANY, SAN FRANCISCO • TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM

UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

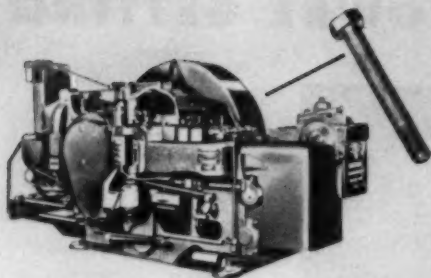


## Carilloy Steels

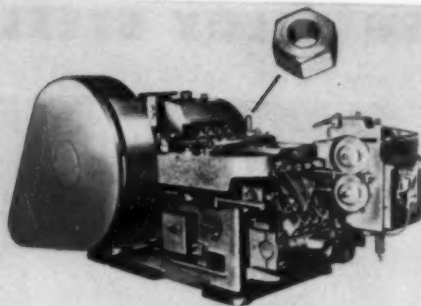
ELECTRIC FURNACE OR OPEN HEARTH • COMPLETE PRODUCTION FACILITIES IN CHICAGO AND PITTSBURGH

1-1127

UNITED STATES STEEL



BOLTMAKER

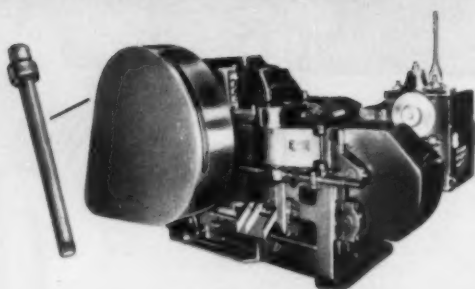


COLD NUT FORMER

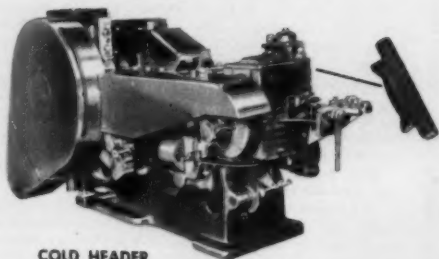
# *Our Job:* HELPING YOU



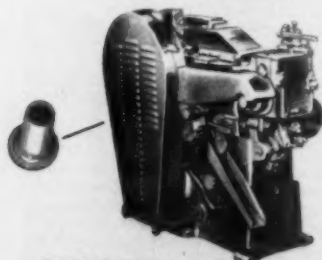
NAILMAKER



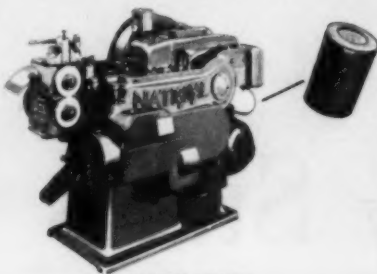
PROGRESSIVE HEADER



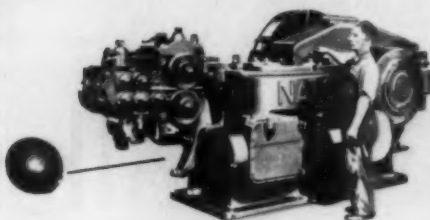
COLD HEADER



TUBULAR RIVET HEADER



ROLLER HEADER



BALL HEADER



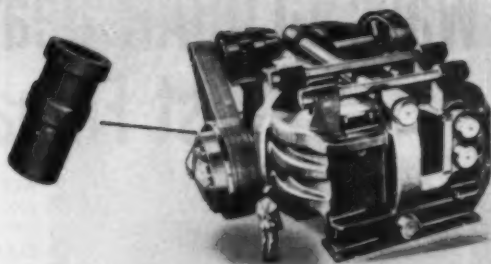
● Most people think of metal as an unyielding solid. To us it's fluid, even when cold. For 76 years our business has been the development of methods and machines which make metal *flow by pressure* into shapes required for the countless parts used in industry.

In peace and war, a growing share of the world's forgings, fasteners and other parts are being made on NATIONAL-built machines.

For example, large automobile crankshafts are finish-forged on a MAXIPRES weighing 1,600,000 pounds . . . five-penny nails stream from a NAILMAKER all day long 13 a second . . . ball-point pen balls, so small it takes 111,000 to make a pound, are made automatically from coiled wire on the smallest Cold Header.

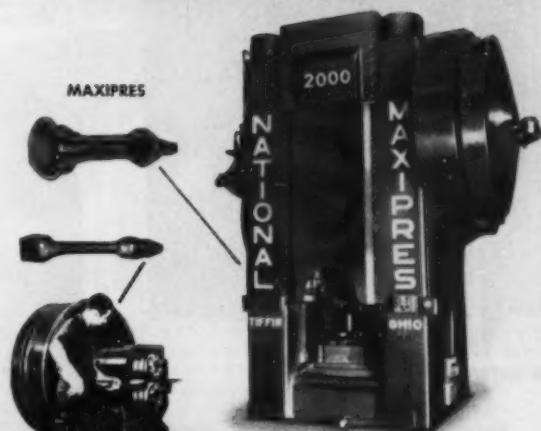
NATIONAL'S all-around experience covers the full range of forging—hot and cold, large and small, ferrous and non-ferrous.

If you have a forging problem—hot or cold—or feel you might benefit by converting a certain part to a forging, why not have us take a look at it?



FORGING MACHINE

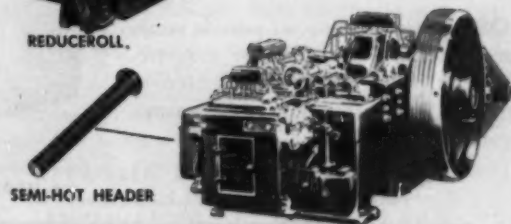
## "FLOW" METAL!



MAXIPRES



REDUCEROLL



SEMI-HOT HEADER



**THIS DOOR IS ALWAYS  
OPEN**

Send us a print or sample of your job. Better yet, pay us a visit. No obligation.

**NATIONAL**  
MACHINERY COMPANY  
TIFFIN, OHIO.

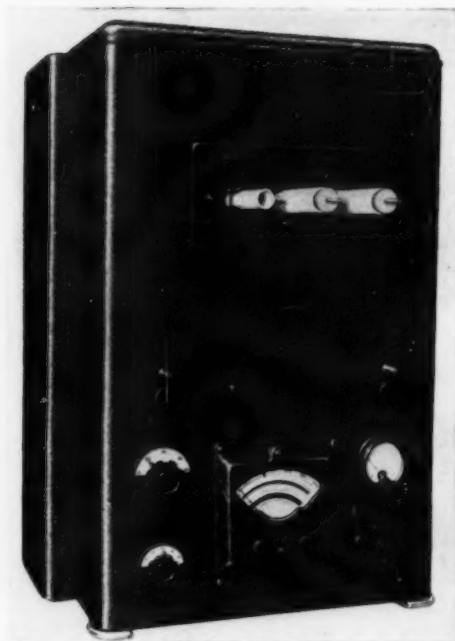
DESIGNERS AND BUILDERS OF MODERN FORGING MACHINES—MAXIPRESSES—COLD HEADERS—AND BOLT, NUT, RIVET, AND WIRE NAIL MACHINERY

Hartford

Detroit

Chicago

# 4 Ways GLOBAL Heating Elements Boost Furnace Performance



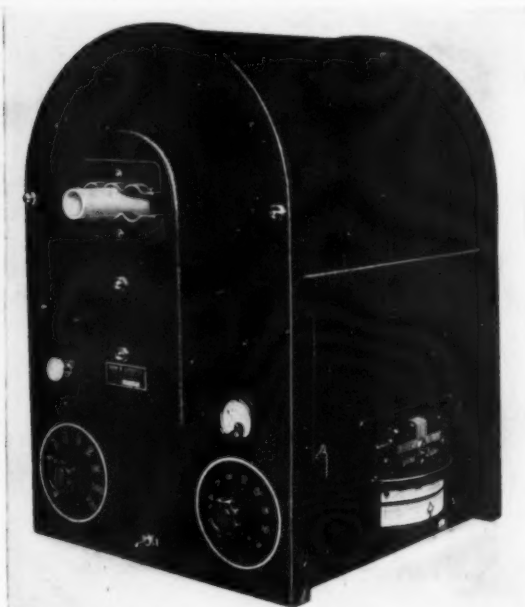
● HITEMP

*Furnaces illustrated are made by Harry W. Dietert Company, Detroit, Michigan*

**GLOBAL** heating elements provide many other important advantages. For complete information, write Dept. MP 101, GLOBAL Division, The Carborundum Company, Niagara Falls, New York.

- 1 ACCURATE.** GLOBAL silicon carbide elements when properly applied and operated assure uniform temperatures... maintain consistent product quality.
- 2 CLEAN.** GLOBAL heating elements radiate clean efficient heat.
- 3 DEPENDABLE.** GLOBAL elements can be depended upon for long economical life. Help you maintain production schedules. Easy to install and service.
- 4 VERSATILE.** GLOBAL elements are specified "musts" by many leading users of electric furnaces. Used successfully for most types of heat treating applications.

**DIETERT USES GLOBAL ELEMENTS.** Accuracy is essential in all phases of design, construction and operation of high temperature laboratory combustion furnaces. GLOBAL elements meet all requirements... add to efficient performance of such furnaces.



● VARITEMP



## GLOBAL Heating Elements

BY **CARBORUNDUM**

TRADE MARK

"Carborundum" and "Global" are registered trademarks which indicate manufacture by The Carborundum Company



## We've come to RELIEVE YOUR HEADACHE

If you use alloy steels, you know the headache we mean . . . shortages and restrictions on the analyses you've been accustomed to using. Because certain alloying elements are required for vital defense jobs, you may be unable to get the particular alloy you're tooled up to use.

And that's where WE come in . . .

Use the 3-dimensional Metallurgical Service that only Republic can give to shift your designs, your products, and your production lines to currently-available alloy steels. The Republic Field Metallurgist, backed up by the Republic Mill and Laboratory Metallurgists, and working as an advisor to your own staff can help make that shift easier for you.

Realignment of alloy steel analyses and their elements is a job to be handled by skilled metallurgists and manufacturing men. It will pay you to let Republic—world's largest producer of alloy and stainless steels—pick the best alloy available. Which alloy? Ask the Republic Metallurgist.

### REPUBLIC STEEL CORPORATION

*Alloy Steel Division • Massillon, Ohio*

GENERAL OFFICES • CLEVELAND 1, OHIO

Export Department: Chrysler Building, New York 17, N. Y.



...combines the extensive experience and co-ordinated abilities of Republic's *Field, Mill and Laboratory* Metallurgists with the knowledge and skills of your own engineers. It has helped guide users of Alloy Steels in countless industries to the correct steel and its most efficient usage. IT CAN DO THE SAME FOR YOU.



Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Plates, Pipe, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

*for*  
**dependable  
hardenability  
in low alloy steels**

USE *Grainal* ALLOYS

For electric furnace steels as well as for open hearth steels, Grainal alloys are used successfully to increase hardenability.

An appreciably larger quantity of Grainal is usually required in electric furnace practice because of the higher nitrogen content characteristic of steels produced by this method. The conversion of the nitrogen content of the steel to an ineffective compound, as is done by some of the components of Grainal, permits a minimum amount of boron to produce the desired effects.

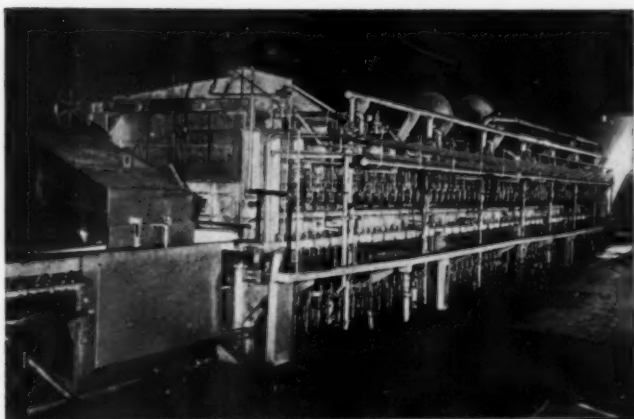
Grainal alloys are metallurgically balanced so that the larger additions required by electric furnace steels can be made safely without exceeding the boron limit for hot shortness.

**VANADIUM CORPORATION OF AMERICA**

200 LEXINGTON AVENUE, NEW YORK 17, N. Y. • DETROIT • CHICAGO • CLEVELAND • PITTSBURGH

MAKERS OF ALLOYS

  
CHEMICALS AND METALS



#### **GAS MACHINERY COMPANY**

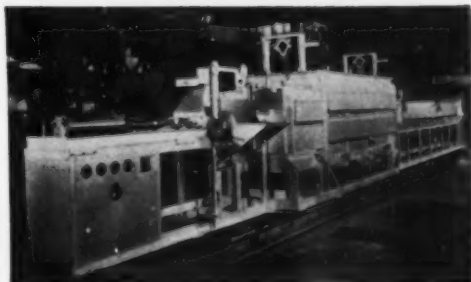
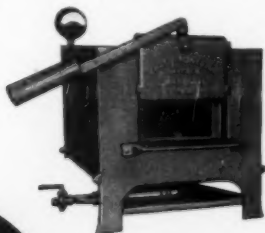
This roller hearth type furnace for annealing stainless steel sheet is equipped with CARBOFRAX silicon carbide rolls. Consequently, the hearth stays straight, the rolls last longer, and there is less marking and pick-up than with metal rolls. The furnace is gas fired to 2450°F with CARBOFRAX radiant tubes located above and below the hearth. CARBOFRAX radiant tubes provide high heat conductivity, excellent refractoriness and the necessary gas tightness.

## **Super Refractories by CARBORUNDUM are used in almost every heat-treating furnace**

Are your furnace floors tough enough to withstand heavy abrasion at high temperatures? Does your hearth or muffle transfer heat as fast as it should—i.e., so that you get the maximum number of heats? Do your supports keep the floor level under heavy loads? Do your burner ports or other furnace parts crack or spall?

As so many furnace manufacturers know, the answer to these problems lies in a well balanced team of heavy-duty, special purpose refractories—Super Refractories by CARBORUNDUM.

Our 40-page booklet, "Super Refractories for Heat Treatment Furnaces" gives specific recommendations. May we send you a copy?



#### **HARPER ELECTRIC FURNACE CORPORATION**

This electrically heated pusher-type furnace is used for sintering powdered metal parts in special atmospheres at 2100°F. It uses an ALFRAX K electrically fused alumina hearth with MULLFRAX electric furnace mullite roof and lintels. The ALFRAX K hearth supports an inconel muffle and is used because of its thermal conductivity, good hot strength and long life. The MULLFRAX material is used for its exceptional strength at high temperatures.

#### **CHARLES A. HONES, INCORPORATED**

This bench type oven furnace is gas fired. It is designed to heat up to 1400°F in 15 minutes and to 2000°F in 50 minutes without the use of gas boosters, blowers, etc. Here, the high heat conductivity of the CARBOFRAX hearth is of real value—as is its extreme resistance to both mechanical abrasion and to heat shock.



## **THE CARBORUNDUM COMPANY**

Dept. C-101, Refractories Div.

Perth Amboy, N. J.

*"Carborundum," "Alfrax," "Carbofrax," and "Mullfrax" are registered trademarks which indicate manufacture by The Carborundum Company.*



# ENGINEERING PIONEERING



## Special REFRACTORIES

MAKING BETTER PRODUCTS TO MAKE OTHER PRODUCTS BETTER

... For the Metal Processing Industry



# Norton *Special* Refractories Are Engineered To Fit Your Exact Requirements

You are always looking for new ways to improve your products, increase your production and lower your costs. That's why you'll find a valuable partner in Norton Refractory Research.

For 40 years, Norton Research has pioneered in the development of special refractories for high temperature applications that are complicated by chemical, electrical, and physical variables.

Working with many electric furnace products, Norton Research has created a wide variety of special refractories having properties of great value in metal processing. These are CRYSTOLON\* (silicon carbide), ALUNDUM\* (fused alumina), MAGNORITE\* (fused magnesia), and FUSED STABILIZED ZIRCONIA. A few of these products are discussed here. For more complete information, call your nearby Norton refractories engineer, or write Norton Company, Refractories Division, Worcester 6, Mass.



**IN HIGH FREQUENCY INDUCTION FURNACES**, you can melt more steel as well as heat- and corrosion-resistant alloys per lining using Norton MAGNORITE cement. Designed specifically to be rammed dry, it begins to mature at 2100° F. and withstands temperatures up to 3250° F. Only the inner face matures during the wash heat, thereby eliminating shrinkage cracks which permit metal penetration that can short out your furnace. MAGNORITE crucibles are available for smaller furnaces.

**For melting platinum and its alloys** Norton FUSED STABILIZED ZIRCONIA crucibles are ideal. Since they are not wetted by the metal, you recover 100% of the melt without destroying the crucible and can also use the same furnace for different alloys without contamination.

**IN INDIRECT ARC FURNACES** you'll get the results you want with Norton ALUNDUM and MAGNORITE corks and covers or cements. As these products are made to meet individual requirements, send us your specifications for the recommendation that will assure you the most satisfactory results.



**IN LOW FREQUENCY INDUCTION FURNACES**, you have a choice of ALUNDUM and MAGNORITE cements, depending upon the metals you are melting. Long lining life is obtained in melting the refractory alloys, including cupronickel, nickel silver, high copper alloy, as well as Al, Te, and Si bronzes, because of the great refractoriness of these cements. Greater economy is also realized because of their high rammed density which resists metal penetration and erosion.

**IN PIT, CRUCIBLE, AND REVERBERATORY FURNACES** for non-ferrous melting, linings of Norton CRYSTOLON cements and fired shapes let you melt more metal with fewer interruptions for maintenance. Fired shapes of CRYSTOLON refractory are also available for special applications. For example, CRYSTOLON protection tubes are being successfully used for more accurate control of metal temperatures.



**IN BACK-SLAGGING CUPOLAS**, slag hole blocks made of Norton CRYSTOLON refractory enable you to complete your campaigns without stopping for replacement. Made of densely bonded, chemically inert silicon carbide grain, they resist corrosion, erosion, and penetration of slag many times longer than fireclay blocks. No softening or spalling at temperatures up to 3050° F. It will pay you to compare Norton CRYSTOLON slag hole blocks with whatever you are now using.



**IN HEAT-TREATING AND SINTERING FURNACES**, a wide variety of Norton refractory products are contributing to higher operating temperatures and lower operating costs. ALUNDUM and CRYSTOLON hearthplates, pier brick, burner blocks, muffles, muffle plates, skid rails, burner tunnel cements, and embedding cements offer such desirable properties as high refractoriness and excellent resistance to spalling, corrosion, and erosion.



**WHATEVER YOUR REFRACTORY APPLICATION**, Norton Research assures you the most practical application of special refractories to your individual requirements.

### WHAT IS YOUR *Special* REFRACTORY PROBLEM?

Do you want refractories that last longer... that allow higher operating temperatures... that resist certain chemical reactions... that are more resistant to thermal shock and abrasion... that are better thermal conductors... that are better insulators... that have special electrical properties?

In other words, do you want refractory products tailored to your exact requirements?

Then, Norton Research is the answer. Describe your product, process, and operating conditions to your nearby Norton Representative. He will take the steps immediately to assure you the most satisfactory solution of your problem.

Why be satisfied with refractories that are just good enough, when you may be able to improve your processes and reduce your operating costs with Norton special refractories that are tailored to your individual requirements? Contact your Norton Representative today — or write

#### **NORTON COMPANY**

*Refractories Division*

329 New Bond Street, Worcester 6, Mass.



### **Special REFRACTORIES**

**MAKING BETTER PRODUCTS TO MAKE OTHER PRODUCTS BETTER**



# Metal Progress

Vol. 60, No. 4 • October 1951

Copyright, 1951, by AMERICAN SOCIETY FOR METALS, 7301 Euclid Ave., Cleveland 3, Ohio. Published monthly; subscription \$7.50 a year in U.S. and Canada; foreign \$10.50. Single copies \$1.50; special issues \$2.00. Entered as second-class matter, Feb. 7, 1921, at the post office

at Cleveland, under the Act of March 3, 1879 . . . The AMERICAN SOCIETY FOR METALS is not responsible for statements or opinions printed in this publication . . . Requests for change in address should include old address of the subscriber; missing numbers due to "change in address" cannot be replaced. Claims for nondelivered copies must be made within 60 days.

ERNEST E. THUM, *Editor*

JOHN PARINA, JR., *Associate Editor*

Cover by Vincent Rapini

## World Metallurgical Congress

A Statement by the President	67
Walter E. Jominy	
Consolidated Program	68
Details of Technical Program	70

## Technical Articles

A New Process for Direct Reduction of Iron Pyrites	72
by Antonio Scortecchi and Massimo Scortecchi	
The "Onera" Bright Chromizing Process	76
by Bernard Jousset	
Bessemer Steel Low in Nitrogen and Phosphorus	78
by Pierre Coheur	
Drawing Limits for Rectangular Boxes	80
by Toshisada Ishikawa	
High Permeability "Sendust" Powder Ring Cores	83
by E. G. Thurlby	
Continuous Heat Treatment of Aluminum Alloy Strip	88
by Marcel Lamourdedieu	
Iron and Steel Industry in India	93
by P. E. Mehta	
Improved Aluminum Bearings (Al-Sn and Al-Sn-Cu Alloys)	97
by H. K. Hardy, E. A. G. Liddiard, J. Y. Higgs and J. M. Cunthbertson	
Deep Welding—a New Method of Oxy-Acetylene Welding	104
by R. Gunnert	

## Correspondence

Surface Hardening of Nodular Cast Iron With High-Frequency Currents	108
by Takao Takase	
Russian Metallurgical Texts	108
by N. H. Polakowski	
Corresponding or Homologous Temperatures	109
by Albert M. Portevin	
The Festival of Britain	110
by M. Riddihough	
Acceptance Tests for High Speed Tools	110
by John Garland	
Carbide Phase in Tempered Steel	111
by K. H. Jack	

## Departments

Data Sheet: List of Notables	96-B
------------------------------	------

Personals	114
Engineering Digest of New Products	23
Manufacturers' Literature	31

## Abstracts of Important Articles

Effect of Sinter on Blast Furnace Production	162
Abstract of "The Effect of Sinter on Blast Furnace Production as Determined by Analysis of Daily Operating Data", by W. E. Marshall, American Iron and Steel Institute, general meeting, 1951.	
Tensile Strength of Warm Worked Austenitic Steel	166
Abstract of "Effect of Warm Working on an Austenitic Steel (G18B)", by G. T. Harris and W. H. Bailey, Symposium on High-Temperature Steels and Alloys for Gas Turbines, Iron and Steel Institute, February 1951.	
Welding Characteristics of Two Austenitic Steels Used for Gas-Turbine Rotors	170
Abstract of "Weld-Metal Properties and Welding Characteristics of Two Austenitic Steels Used for Gas-Turbine Rotors", by E. Bishop and W. H. Bailey, Symposium on High-Temperature Steels and Alloys for Gas Turbines, Iron and Steel Institute, February 1951.	
Properties of Electroplates	182
Abstract of "The Physical and Engineering Properties of Electrodeposited Metals", by J. S. Anderson, Australian Institute of Metals' Symposium on Electrodeposited Metals, 1949.	
Fatigue Resistance of Heat Treated Aluminum and Beryllium Bronzes	190
Abstract of "The Resistance of Aluminum and Beryllium Bronzes to Fatigue and Corrosion Fatigue", by D. G. Sopwith, Report 2486, Aeronautical Research Council.	
Centrifugal Method of Testing at High Temperatures	194
Abstracted from Russian papers by I. I. Kornilov and M. E. Rabinovich.	
Oxygen Cutting	206
Abstracted from "New Data on the Oxygen Cutting of Steel", by F. Pfeleiderer, <i>Journal de la Soudure</i> , Vol. 38, 1948, p. 151.	
Explosion Deformation Tests of Weldments	212
Abstract of "Explosion Bulge Test Studies of the Deformation of Weldments", by C. E. Hartbower and W. S. Pellini, <i>Welding Research Supplement</i> , Vol. 16, 1951, p. 307s.	
Gaseous Annealing of Black-Heart Malleable Iron	226
Abstract of "Gaseous Annealing of Malleable Castings, Part II—Black-Heart Malleable", by P. F. Hancock, <i>Journal of Research and Development</i> , Vol. 3, April 1951, p. 913.	



## How to Take Chance Out of Today's Alloy Buying

Here's a spark tester checking bars of Ryerson alloy steel. By reading the spark pattern thrown off when each bar is touched with this whirling, abrasive wheel, the tester determines the steel's analysis. In this way he verifies quality—guards against mixed steels.

Spark testing is only one of many steps in the Ryerson Certified Steel Plan for safer alloy buying—a plan especially important to you today, while restrictions are enforcing the use of leaner alloys with unfamiliar heat treatment response.

We also put every heat of Ryerson alloy steel through four separate hardenability tests, carefully recording the results on a Ryerson Alloy Certificate which goes with the steel. These tests enable you to buy Ryerson alloys on the basis of hardenability as well as analysis—the safest way to buy under today's changing conditions. And the recorded test results safely guide your heat treatment.

So play safe. Order from Ryerson where you can specify hardenability and be doubly sure. Stocks are out of balance from a size standpoint, but in all probability we can take care of your requirements.

### PRINCIPAL PRODUCTS

**CARBON STEEL BARS**—Hot rolled and cold finished

**STRUCTURALS**—Channels, angles, beams, etc.

**PLATES**—Many types including Inland 4-Way Safety Plate

**SHEETS**—Hot and cold rolled, many types and coatings

**TUBING**—Seamless and welded, mechanical and boiler tubes

**ALLOYS**—Hot rolled, cold finished, heat treated

**STAINLESS**—Allegheny bars, plates, sheets, tubes, etc.

**REINFORCING**—Bars and accessories, spirals, wire mesh

**BABBIT**—Five grades, also Ryertex plastic bearings

**MACHINERY & TOOLS**—For metal fabrication

# RYERSON STEEL

JOSEPH T. RYERSON & SON, INC. PLANTS AT: NEW YORK • BOSTON • PHILADELPHIA • CINCINNATI • CLEVELAND  
DETROIT • PITTSBURGH • BUFFALO • CHICAGO • MILWAUKEE • ST. LOUIS • LOS ANGELES • SAN FRANCISCO

# The World Metallurgical Congress

## A Statement by the President, ☉

**F**RIENDSHIP, cooperation, mutual assistance among metal scientists and metallurgical engineers of the free world to promote a peaceful and advancing civilization is well symbolized in the handsome bronze medal prepared for conferees to the first World Metallurgical Congress. It is fitting that the American Society for Metals, the world's premier association of men interested in manufacture and utilization of superior metals and alloys, should be the sponsor of this Congress, and that all the facilities and advantages of the A.S.M.'s Annual Convention and National Metal Exposition should be thrown open to our visitors from overseas.

We confess that we Americans expect to get as much from our visitors as we give! Everyone who has participated even in a small way in those familiar (to us) activities known as engineering societies knows that when he brings ideas into a congenial group they generate new ideas; all become richer for the interchange. It is therefore a rare privilege which members of the ☉ will embrace to come to Detroit—by Oct. 13 if possible—and extend personal welcome to our visitors, enter into the professional discussions at the group meetings and technical sessions, meet them socially, show them how free men in a free country conduct themselves.

I recommend that everyone examine the consolidated general program in the following pages and get an idea of the variegated activities, then go on to the list of American and foreign papers to be presented in the regular technical programs, and finally read the articles in this issue of *Metal Progress*, exclusively given over to a small sampling of the contributions from foreign lands. An inescapable conclusion is that here is intellectual fare of supreme quality. Fifteen of the papers by foreign conferees find place in the ☉ technical program; the balance will be considered in the group meetings; the entire 47 will be published in a separate volume containing the proceedings of the World Metallurgical Congress.

It would be well to recount briefly the inception of this Congress. It was conceived by Wm. H.

Eisenman and first presented by him and my predecessor as president of the ☉, Arthur E. Focke, to Paul G. Hoffman, then head of the Economic Cooperation Administration, in December 1949. It met instant acceptance, but time proved too short to make the multitudinous arrangements before our convention last year in Chicago. Consequently, the Congress was deferred until 1951 and really got off to a flying start during the European tour early this year of Zay Jeffries, past president ☉ and director general of the World Metallurgical Congress.

While Secretary Eisenman originated the broad project and gave a large share of his time to the planning in all its details, Ernest E. Thum, editor of *Metal Progress*, acted in his behalf during those periods when Mr. Eisenman was necessarily absent, organized the eight four-week tours in various branches of our metal industry, and the general activities for conferees during convention week. Many contacts with the American governmental agencies and foreign embassies were made in Washington by John W. Barnett, ☉, assistant director general of the Congress. Kingsley W. Given, formerly of General Electric's staff, served as executive assistant and superintended the activities of four other temporary employees in working out the details of reception, travel and plant visitations. Marjorie Rud Hyslop, editor of *Metals Review*, acted as registrar and supervised the voluminous correspondence. Ray T. Bayless, assistant secretary ☉, attended to details of the Detroit technical conferences and all matters concerning publication. A. A. Hess, assistant treasurer, worked out the special accounting methods required by the E.C.A.

It is not too much to say that every member of the ☉ general office staff took a share in the extraordinarily diverse arrangements for the World Metallurgical Congress, and I have been gratified by the unselfish manner in which they have contributed the necessary extra effort. When working together, as free men and women know how to do, success is assured.

WALTER E. JOMINY  
President

American Society for Metals

Glenn M. Shaw, Designer  
Walter A. Sinz, Sculptor  
Medallic Art Co., Manufacturer



• CONSOLIDATED PROGRAM •

# 33d National Metal Congress and First World Metallurgical Congress

AMERICAN SOCIETY FOR METALS

INSTITUTE OF METALS DIVISION,

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS (A.I.M.E.)

AMERICAN WELDING SOCIETY (A.W.S.)

SOCIETY FOR NON-DESTRUCTIVE TESTING (S.N.T.)

SPECIAL LIBRARIES ASSOCIATION (S.L.A.)

## Saturday, October 13, 1951

10:00 A.M. and 2:00 P.M. Seminar: Interfaces; Ballroom, Statler Hotel

## Sunday, October 14, 1951

10:00 A.M. Seminar: Interfaces; Ballroom, Statler Hotel  
2:00 P.M. Seminar: Interfaces; Wayne Room, Statler Hotel  
2:00 P.M. and W.M.C. Conferee Meeting; Hall of Friendship, Hotel Tuller  
4:00 P.M. and W.M.C. Civic Reception; Ballroom, Statler Hotel  
7:00 P.M. A.I.M.E. Program Committee; Tropical Room, Detroit-Leland Hotel  
7:00 P.M. A.I.M.E. Publications Committee; New York Room, Detroit-Leland Hotel  
8:00 P.M. First Meeting of W.M.C.; Ballroom, Statler Hotel

## Monday, October 15, 1951

9:00 A.M. A.I.M.E. Grain Growth and Recrystallization; Jade Room, Detroit-Leland Hotel  
9:00 A.M. A.I.M.E. Alloys Systems; Colonial Room, Detroit-Leland Hotel  
9:30 A.M. W.M.C. Tour Groups 2, 6 and 8 Meetings; Hotel Tuller  
9:30 A.M. Constitution Diagrams; Ballroom, Statler Hotel  
9:30 A.M. W.M.C. Melting and Refining; Wayne Room, Statler Hotel  
9:30 A.M. A.W.S. Structural Welding; Crystal Ballroom, Book-Cadillac Hotel  
9:30 A.M. A.W.S. Resistance Welding; Italian Garden, Book-Cadillac Hotel  
9:30 A.M. S.N.T. Technical Session; Flamingo Room, Hotel Detroit  
12:00 M. Opening of National Metal Exposition and House of Friendship; Michigan State Fair Grounds  
2:00 P.M. W.M.C. Tour Groups 3, 4 and 11 Meetings; Michigan State Fair Grounds  
2:00 P.M. Diffusion, Building M, Fair Grounds

## Monday's Program, Continued

2:00 P.M. A.I.M.E. Dislocations in Metals; Jade Room, Detroit-Leland Hotel  
2:00 P.M. A.W.S. Resistance Welding; Italian Garden, Book-Cadillac Hotel  
2:00 P.M. A.W.S. Weldability; Grand Ballroom, Book-Cadillac Hotel  
2:00 P.M. A.W.S. Nonferrous; Crystal Ballroom, Book-Cadillac Hotel  
2:00 P.M. S.N.T. Technical Session; Flamingo Room, Hotel Detroit  
4:00 P.M. W.M.C. High Tea; House of Friendship, Fair Grounds  
6:00 P.M. A.W.S. President's Reception; Grand Ballroom, Book-Cadillac Hotel  
7:00 P.M. A.I.M.E. Membership Committee; New York Room, Detroit-Leland Hotel  
8:00 P.M. First Lecture: Residual Stress Measurements; Building M, Fair Grounds  
8:00 P.M. A.I.M.E. Dislocations in Metals; Jade Room, Detroit-Leland Hotel

## Tuesday, October 16, 1951

9:00 A.M. A.I.M.E. Transformations; Jade Room, Detroit-Leland Hotel  
9:00 A.M. A.I.M.E. Alloy Systems; Colonial Room, Detroit-Leland Hotel  
9:30 A.M. Tour Groups 1, 5 and 9 Meetings; Hotel Tuller  
9:30 A.M. W.M.C. High-Temperature Alloys; Ballroom, Statler Hotel  
9:30 A.M. W.M.C. Mechanical Metallurgy; Wayne Room, Statler Hotel  
9:30 A.M. A.W.S. Ship Structure; Crystal Ballroom, Book-Cadillac Hotel  
9:30 A.M. A.W.S. Arc Welding; Italian Garden, Book-Cadillac Hotel  
9:30 A.M. S.N.T. Technical Session; Flamingo Room, Hotel Detroit

Exposition and House of Friendship  
Open 12:00 M. to 10:30 P.M.

### *Tuesday's Program, Continued*

- 12:15 P.M. A.I.M.E. Executive Committee Luncheon; New York Room, Detroit-Leland Hotel
- 2:00 P.M. W.M.C. Tour Groups Meetings; Fair Grounds
- 2:00 P.M. ☉ High-Temperature Alloys; Building M, Fair Grounds
- 2:00 P.M. A.I.M.E. Light Metals; Jade Room, Detroit-Leland Hotel
- 2:00 P.M. A.I.M.E. Creep; Colonial Room, Detroit-Leland Hotel
- 2:00 P.M. A.W.S. Ship Structure; Crystal Ballroom, Book-Cadillac Hotel
- 2:00 P.M. A.W.S. Hard Facing and Flame Hardening; Grand Ballroom, Book-Cadillac Hotel
- 2:00 P.M. A.W.S. Resistance Welding; Italian Garden, Book-Cadillac Hotel
- 2:00 P.M. S.N.T. Technical Session; Flamingo Room, Hotel Detroit
- 4:00 P.M. W.M.C. High Tea; House of Friendship, Fair Grounds
- 4:30 P.M. ☉ Heat Treatment; Building M, Fair Grounds
- 4:30 P.M. A.W.S. Educational Lecture; Italian Garden, Book-Cadillac Hotel
- 7:00 P.M. A.I.M.E. Annual Fall Dinner; Jade Room, Detroit-Leland Hotel
- 8:00 P.M. ☉ Residual Stress Measurements; Building M, Fair Grounds
- 8:00 P.M. A.W.S. Adams Lecture; Crystal Ballroom, Book-Cadillac Hotel

### *Wednesday, October 17, 1951*

- 9:00 A.M. ☉ Annual Meeting; Ballroom, Statler Hotel
- 9:30 A.M. ☉ Campbell Memorial Lecture; Ballroom, Statler Hotel
- 9:30 A.M. A.W.S. Production Welding; Crystal Ballroom, Book-Cadillac Hotel
- 9:30 A.M. A.W.S. Pressure Vessels; Grand Ballroom, Book-Cadillac Hotel
- 9:30 A.M. A.W.S. Gas Cutting; Italian Garden, Book-Cadillac Hotel
- 9:30 A.M. S.N.T. Ordnance Material Testing; Flamingo Room, Hotel Detroit
- 12:00 M. American College Alumni Luncheon; Statler Hotel and Hotel Tuller

Exposition and ☉ House of Friendship  
Open 12:00 M. to 10:30 P.M.

- 12:15 P.M. A.I.M.E. Powder Metallurgy Committee Luncheon; New York Room, Detroit-Leland Hotel
- 2:00 P.M. W.M.C. Adjourned Meetings of Study Tour Groups 1 through 12; Fair Grounds
- 2:00 P.M. ☉ Embrittlement; Building M, Fair Grounds
- 2:00 P.M. A.W.S. Weldability; Grand Ballroom, Book-Cadillac Hotel
- 2:00 P.M. A.W.S. Welding and Brazing; Crystal Ballroom, Book-Cadillac Hotel
- 2:00 P.M. A.W.S. Stainless Steels; Italian Garden, Book-Cadillac Hotel
- 2:00 P.M. A.I.M.E. High-Temperature Oxidation; Colonial Room, Detroit-Leland Hotel
- 2:00 P.M. S.N.T. Jet Engine Part Inspection; Flamingo Room, Hotel Detroit
- 2:30 P.M. A.I.M.E. Powder Metallurgy; Jade Room, Detroit-Leland Hotel

### *Wednesday's Program, Continued*

- 4:00 P.M. W.M.C. High Tea; House of Friendship, Fair Grounds
- 4:30 P.M. ☉ Heat Treatment; Building M, Fair Grounds
- 4:30 P.M. A.W.S. Educational Lecture, Italian Garden, Book-Cadillac Hotel
- 7:30 P.M. A.W.S. University Research Conference; Founders Room, Book-Cadillac Hotel
- 8:00 P.M. ☉ Heat Treatment; Building M, Fair Grounds

### *Thursday, October 18, 1951*

- 9:30 A.M. W.M.C. Adjourned Meetings of Study Tour Groups 1 through 12; Michigan State Fair Grounds
- 9:30 A.M. ☉ W.M.C. High-Temperature Phases; Building M, Fair Grounds
- 9:30 A.M. A.W.S. Educational; Crystal Ballroom, Book-Cadillac Hotel
- 9:30 A.M. A.W.S. Weldability; Italian Garden, Book-Cadillac Hotel
- 9:30 A.M. A.W.S. Inert Arc Welding; Grand Ballroom, Book-Cadillac Hotel
- 9:30 A.M. S.N.T. Technical Session; Flamingo Room, Hotel Detroit
- 10:00 A.M. S.L.A. Technical Session; English Room, Statler Hotel

Exposition and ☉ House of Friendship  
Open 10:00 A.M. to 6:00 P.M.

- 2:00 P.M. W.M.C. Adjourned Meetings of Study Tour Groups 1 through 12; Building M, Fair Grounds
- 2:00 P.M. ☉ Heat Treatment; Building M, Fair Grounds
- 2:00 P.M. A.W.S. Filler Metal Specifications for Inert Gas and Submerged Arc Welding; Crystal Ballroom, Book-Cadillac Hotel
- 2:00 P.M. A.W.S. Business Meeting; Italian Garden, Book-Cadillac Hotel
- 2:00 P.M. S.N.T. Honor Lecture and Annual Business Meeting; Flamingo Room, Hotel Detroit
- 2:30 P.M. S.L.A. Technical Session; English Room, Statler Hotel
- 4:00 P.M. W.M.C. High Tea; House of Friendship, Fair Grounds
- 7:30 P.M. A.W.S. Annual Dinner and Presentation of Awards; Grand Ballroom, Book-Cadillac Hotel

### *Friday, October 19, 1951*

- 9:30 A.M. W.M.C. General Meeting of Conferees; Building M, Fair Grounds
- 9:30 A.M. ☉ Physical Metallurgy; Building M, Fair Grounds
- 9:30 A.M. A.W.S. Inert Arc Welding; Crystal Ballroom, Book-Cadillac Hotel
- 9:30 A.M. A.W.S. Metallizing; Italian Garden, Book-Cadillac Hotel
- 9:30 A.M. S.L.A. Technical Session; English Room, Statler Hotel

Exposition and ☉ House of Friendship  
Open 10:00 A.M. to 6:00 P.M.

- 2:00 P.M. W.M.C. General Meeting of Conferees; Building M, Fair Grounds
- 2:00 P.M. S.L.A. Technical Session; English Room, Statler Hotel
- 7:00 P.M. W.M.C. Farewell Dinner for Conferees; Ballroom, Statler Hotel



# Details of Program

## Saturday, Oct. 13, and Sunday, Oct. 14

Seminar on Metal Interfaces

9:30 A. M. and 2:00 P. M.

BALLROOM, STATLER HOTEL

WAYNE ROOM, STATLER HOTEL

A symposium of 13 papers with discussions

## Sunday Evening, Oct. 14

8:00 P. M.—World Metal Resources

Opening Session of World Metallurgical Congress

BALLROOM, STATLER HOTEL

Raw Materials for the Metal Industry, by James Boyd, U. S. Department of the Interior.

Defense Metal Conservation and Substitution, by K. P. Harten, German Iron and Steel Institute.

Metals for Defense in the E.C.A. Countries. Speaker to be announced.

Metals for Defense in the Non-E.C.A. Countries of the Free World, by Clyde Williams, Battelle Memorial Institute.

## Monday Morning, Oct. 15

Session on Constitution Diagrams

BALLROOM, STATLER HOTEL

9:30 A. M.—Constitution and Properties of Cobalt-Iron-Vanadium Alloys, by D. L. Martin and A. H. Geisler, General Electric Co., Research Laboratories.

10:00 A. M.—Phase Relationships in the Iron-Chromium-Vanadium System, by Howard Martens and Pol Duwez, California Institute of Technology.

10:30 A. M.—A Partial Titanium-Chromium Phase Diagram and the Crystal Structure of  $TiCr_3$ , by Pol Duwez and Jack L. Taylor, California Institute of Technology.

11:00 A. M.—The Titanium-Silicon System, by M. Hansen, H. D. Kessler and D. J. McPherson, Armour Research Foundation.

11:30 A. M.—The Indium-Antimony System, by T. S. Liu and E. A. Peretti, University of Notre Dame.

Session on Melting and Refining

WAYNE ROOM, STATLER HOTEL

\*9:30 A. M.—A Proposed Steelmaking Process, by A. Reggiore, Societa Italiana Ernesto Breda, Italy.

\*10:00 A. M.—A New Process for Direct Reduction of Iron Pyrites, by A. Scortecchi and M. Scortecchi, Finisider Metallurgical Institute, Italy.

\*10:30 A. M.—A Rapid Analytical Method for Hydrogen in Steel, by Y. Ishihara and S. Sawa, Japan Special Steel Co., Japan.

\*11:00 A. M.—Basic Bessemer Steel With Low Nitrogen and Phosphorus, by P. Coheur, Centre National de Recherches Metallurgiques, Belgium.

\*11:30 A. M.—Phosphorus Deoxidation of Molten Copper, by W. A. Baker, British Non-Ferrous Metals Research Association, England.

## Monday Afternoon and Evening, Oct. 15

Session on Diffusion

BUILDING M, FAIR GROUNDS

2:00 P. M.—Interstitial Diffusion, by A. G. Guy, University of North Carolina.

2:30 P. M.—The Carbonitriding of Carbon and Alloy Steels, by H. C. Fiedler, M. B. Bever and C. F. Floe, Massachusetts Institute of Technology.

3:00 P. M.—Chromium Diffusivity in Alpha Cobalt-Chromium Solid Solutions, by John W. Weeton, Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics.

3:30 P. M.—Anisothermal Diffusion of Carbon in Austenite, by J. E. Black, Captain, Ordnance Department, U. S. Army, Lehigh University.

8:00 P. M.—Lectures on Residual Stress Measurements  
BUILDING M, FAIR GROUNDS

Origin, Nature and Effects of Residual Stresses, by R. G. Treuting, Bell Telephone Laboratories.

Measurements of Residual Stresses, by J. J. Lynch, Case Institute of Technology.

## Tuesday Morning, Oct. 16

Session on High-Temperature Phases

BALLROOM, STATLER HOTEL

9:30 A. M.—The Formation of Sigma Phase in 13 to 16% Chromium Steels, by H. S. Link and P. V. Marshall, U. S. Steel Co., Research and Development Laboratory.

10:00 A. M.—Electrolytic Etching—The Sigma Phase Steels, by John J. Gilman, Crucible Steel Co. of America, Research Laboratory.

\*10:30 A. M.—Phase Changes Associated With Sigma Formation in 18-8-3-1 Chromium-Nickel-Molybdenum-Titanium Steel, by K. W. Bowen and T. P. Hoar, University of Cambridge, England.

11:00 A. M.—Composition Limits of Sigma Formation in Nickel-Chromium Steels at 1200° F. (650° C.), by M. E. Nicholson, University of Chicago; C. H. Samans, Standard Oil Co. (Indiana); and F. J. Shortleeve, Case Institute of Technology.

11:30 A. M.—Ferrite Formation Associated With Carbide Precipitation in 18 Cr, 8 Ni Austenitic Stainless Steel, by E. J. Dulis and G. V. Smith, U. S. Steel Co.

Session on Mechanical Metallurgy

WAYNE ROOM, STATLER HOTEL

9:30 A. M.—The Determination of Flow Stress From a Tensile Specimen, by E. R. Marshall and M. C. Shaw, Massachusetts Institute of Technology.

\*10:00 A. M.—Plastic Deformation of Zinc Bicrystals, by T. Kawada, Government Mechanical Laboratory, Ministry of International Trade and Industry, Japan.

\*10:30 A. M.—The Mechanical Properties of Iron and Some Iron Alloys of High Purity, by W. P. Rees, National Physical Laboratory, England.

\*11:00 A. M.—Crystal Orientation in Cold-Rolled Silicon Steel Sheet, by I. Gokyu and H. Abe, Tokyo University, Japan.

11:30 A. M.—Delayed Yield in Annealed Steels of Very Low Carbon and Nitrogen Content, by D. S. Wood and D. S. Clark, California Institute of Technology.

## Tuesday Afternoon and Evening, Oct. 16

Session on High-Temperature Alloys

BUILDING M, FAIR GROUNDS

2:00 P. M.—Cast Heat Resistant Alloys of the 21% Chromium, 9% Nickel Type, by Howard S. Avery, Charles R. Wilks and John A. Fellows, American Brake Shoe Co.

\*World Metallurgical Congress papers submitted by foreign conferees.

## Tuesday Afternoon and Evening (Cont.)

- 2:30 P. M.—Influence of Extended Time on Creep and Rupture Strength of 16-26-6 Alloy, by C. L. Clark and M. Fleischmann, Timken Roller Bearing Co., and J. W. Freeman, University of Michigan.
- 3:00 P. M.—Isothermal Transformation, Hardening and Tempering of 12% Chromium Steel, by R. L. Rickett, Research Laboratory, U. S. Steel Co.; C. S. Walton and J. C. Butler, U. S. Steel Co.
- 3:30 P. M.—Cladding of Molybdenum for Service in Air at Elevated Temperature, by W. L. Bruckart and R. I. Jaffee, Battelle Memorial Institute.
- 4:30 P. M.—Lecture on Principles of Heat Treatment, by M. A. Grossmann, Director of Research, U. S. Steel Co.

8:00 P. M.—Lectures on Residual Stresses

### BUILDING M, FAIR GROUNDS

- Residual Stress States Produced in Metals by Various Processes, by H. B. Wishart, U. S. Steel Co.
- Relief and Redistribution of Residual Stresses in Metals, by D. G. Richards, United Aircraft Corp.

## Wednesday Morning, Oct. 17

A.S.M. Annual Meeting and Lecture

### BALLROOM, STATLER HOTEL

- 9:30 A. M.—Annual Meeting of the Society
- 10:00 A. M.—Edward DeMille Campbell Memorial Lecture, by C. H. Lorig, Supervising Metallurgist, Battelle Memorial Institute.

## Wednesday Afternoon and Evening, Oct. 17

Session on Embrittlement

### BUILDING M, FAIR GROUNDS

- 2:00 P. M.—Effects of Decomposition of Retained Austenite During Tempering on Notch Toughness and Tensile Properties, by E. F. Bailey and W. J. Harris, Jr., Naval Research Laboratory.
- 2:30 P. M.—Comparison of the Effects of Alloying Elements on the Lower and Upper Transition Temperatures in Pearlitic Steel, by J. A. Rinebolt and W. J. Harris, Jr., Naval Research Laboratory.
- 3:00 P. M.—Effect of Retained Austenite Upon Mechanical Properties, by L. S. Castleman, Atomic Power Div., Westinghouse Electric Corp.; B. L. Averbach and Morris Cohen, Mass. Institute of Technology.
- 3:30 P. M.—Some X-Ray Diffraction and Electron-Microscope Observations on Temper-Brittle Steels, by S. R. Maloof, Springfield Armory.
- 4:30 P. M.—Lecture on Principles of Heat Treatment, by M. A. Grossmann, Director of Research, U. S. Steel Co.
- 8:00 P. M.—Lecture on Principles of Heat Treatment, by M. A. Grossmann, Director of Research, U. S. Steel Co.

## Thursday Morning and Afternoon, Oct. 18

Session on Mechanical Metallurgy

### BALLROOM, STATLER HOTEL

- 9:30 A. M.—Strain Aging Effects, by J. D. Lubahn, Research Laboratory, General Electric Co.
- 10:00 A. M.—Fatigue Strength of Large, Notched Steel Bars Surface Hardened by Gas Heating and by Induction Heating, by S. L. Case, J. M. Berry and H. J. Grover, Battelle Memorial Institute.

- \*10:30 A. M.—Deep Drawing Limits for Rectangular Boxes, by T. Ishikawa, Nippon Aluminum Mfg. Co., Japan.

- \*11:00 A. M.—Elimination of Yield Point Phenomena by Temper Rolling and Roller Leveling, by N. H. Polakowski, University College, England.

- 11:30 A. M.—Effect of High Heating Rate on Some Elevated-Temperature Tensile Properties of Metals, by W. K. Smith, C. C. Woolsey and W. O. Wetmore, Metallurgy Branch, U. S. Naval Ordnance Test Station, China Lake, Calif.

Session on High-Temperature Phases

### WAYNE ROOM, STATLER HOTEL

- \*9:30 A. M.—An Interpretation of the Hysteresis Loops in A<sub>2</sub> and A Transformations of Pure Iron, by Kotaro Honda and Mizuho Sato, Scientific Research Institute, Japan.
- \*10:00 A. M.—Magnetic Property Changes in Iron-Molybdenum Alloys During Aging, by T. Mishima, R. Hasiziti and Y. Kamura, University of Tokyo, Japan.
- \*10:30 A. M.—Age Hardening, by Y. Mishima, Japan.
- 11:00 A. M.—Carbide Reactions in High-Temperature Alloys, by J. R. Lane, Naval Research Laboratory, and N. J. Grant, Massachusetts Institute of Technology.
- \*11:30 A. M.—The Allotropy of Cobalt, by A. G. Metcalfe, Deloro Smelting & Refining Co., Canada.

Session on Heat Treatment

### BUILDING M, FAIR GROUNDS

- 2:00 P. M.—Stress-Induced Transformation of Retained Austenite in Hardened Steel, by B. L. Averbach, S. G. Lorriss and Morris Cohen, Massachusetts Institute of Technology.
- 2:30 P. M.—An Investigation of the Quenching Characteristics of a Salt Bath, by M. J. Sinnott and J. C. Shyne, University of Michigan.
- 3:00 P. M.—Limitations of the End-Quench Hardenability Test, by A. R. Troiano and L. J. Klinger, Case Institute of Technology.
- 3:30 P. M.—A Correlation of End-Quenched Test Bars and Rounds in Terms of Hardness and Cooling Characteristics, by E. W. Weinman, R. W. Thomson and A. L. Boegehold, General Motors Corp., Research Laboratories Division.

## Friday Morning, Oct. 19

Session on Physical Metallurgy

### BUILDING M, FAIR GROUNDS

- 9:30 A. M.—Particle Size Analysis of Metal Powders, by C. C. Gregg and Bernard Kopelman, Sylvania Electric Products Inc.
- 10:00 A. M.—Interrelation of Mechanical Properties, Casting Size, and Microstructure of Ductile Cast Iron, by R. W. Kraft and R. A. Flinn, American Brake Shoe Co.
- 10:30 A. M.—Gas Evolution From Gray Cast Iron During Enameling, by L. F. Porter and P. C. Rosenthal, University of Wisconsin.
- 11:00 A. M.—Aluminum, 6% Magnesium Wrought Alloys for Elevated-Temperature Service, by K. Grube and L. W. Eastwood, Battelle Memorial Institute.
- 11:30 A. M.—A Study of the Microhardness of the Major Carbides in Some High Speed Steels, by P. Leckie-Ewing, Union Twist Drill Co., Butterfield Division, Canada.

\*World Metallurgical Congress papers submitted by foreign conferees.

# A New Process for Direct Reduction of Iron Pyrites

**I**N ADDITION to the conventional blast furnace process, there are a number of other methods for the reduction of iron ore. The more successful of these include electric furnace reduction, iron sponge reduction, the Krupp-Renn process using rotary kilns, and reduction in a low-shaft furnace either with enriched air or not. These have been described by P. E. Cavanagh in "Alternative Iron Smelting Processes" in *Metal Progress* for May 1950.

From a general point of view, such processes may be considered as pilot plants making use of particular ores or deriving their advantage from local conditions. As such, they contribute in a minor way to world-wide industrial production, but are of great significance in gaining experience about methods of getting iron from its available ores.

High-grade iron ores are becoming scarcer all over the world; in several countries use of low-grade iron ores through concentration processes (often complicated and expensive) is being adopted. In view of this situation extensive research for new methods and new ores is being actively pursued.

Because iron pyrites are spread all over the world they probably represent the most suitable material to be considered for new experiments on iron reduction. Actually, pyrite cinders from sulphuric acid plants have been charged into blast furnaces for centuries. In many countries the practice has waned because so much acid is made from elemental sulphur, but the present shortage of such sulphur is again turning attention to the old, inexhaustible source. Even so, use of pyrites in this way, despite the cheap byproduct used for raw material, has two substantial drawbacks: First, the available quantity of pyrite cinders is set by the output of sulphuric acid plants and, second, pyrite cinders that have been roasted require another large

input of energy to reduce them to elemental iron.

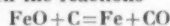
These facts make the development of a direct pyrite reduction process attractive.

One of the authors carried out experiments along these lines as early as 1925. The principle of the process consisted in the dissociation of pyrites in the absence of air, and in the presence of carbon, with the formation

of iron and carbon disulphide. The sulphur content of the pig iron so obtained can be kept at low and technically acceptable values by methods dictated by economic conditions. Practically all the iron present in the pyrites is recovered as pig iron. The carbon disulphide, recovered from small-scale tests, contains as much as 60% of the original sulphur. Other tests showed that it is possible to separate directly some of the elemental sulphur.

Subsequent work was directed primarily to the study and design of larger equipment.

**Early Experiments**—The process was not originated by a systematic research directed toward the reduction of pyrites, but incidentally to some experiments comparing conditions under which the reactions



may develop during gas extraction from steel heated under reduced pressure at a temperature near the melting point.

These tests were carried out in a carbon resistance

furnace under reduced pressure, in an amorphous carbon crucible, originally on steel purposely enriched with sulphur, afterward on synthetic iron sulphide, and finally directly on pyrite mineral. The first experiments with pyrite were stopped shortly after melting occurred; carbon disulphide was given off and the solidified specimen in the crucible contained a button of iron with 2 to 4% sulphur and an upper layer of solid (mostly FeS) with 24 to 26% sulphur. When the melts were held at high temperature for a longer time, the upper layer disappeared and the sulphur content of the iron dropped to 1 to 2%.

Temperatures were estimated as 1700 to 1800° C. (3100 to 3275° F.); the pressure, from 5 to 1 mm. of mercury.

**By Antonio Scortecchi**

Director

Finsider Metallurgical Institute

and Massimo Scortecchi

Italian Institute of Welding

Genoa, Italy

These preliminary results indicated that reduction of pyrites certainly was possible, so further tests were carried out in a small arc furnace (Fig. 1) lined with a carbon ramming mixture. Seventeen experiments made with this furnace went off easily and produced iron, carbon disulphide, and free sulphur.

Data on these runs are reported here:

Pyrite analyzing 46.4% Fe, 44.4% S and 7.3%  $\text{SiO}_2$  was charged with coke into the cold furnace in the proportion of 90 parts pyrite and 7 parts coke. The operation could be followed by noting the production of  $\text{CS}_2$  and by the shape of the flame (see Fig. 1). When no more sulphide was produced, three parts of lime were charged to the furnace. These runs yielded 5 to 6 lb. of iron from 15½ lb. of pyrite, 3.3 to 4 lb. of carbon disulphide and from zero to 1.3 lb. of sulphur (the latter being found in the pipe connecting the furnace to the condenser).

In some experiments, the remaining iron was cooled in the furnace; on complete cooling, both furnace walls and the iron mass were covered with a thick layer of beautiful lamellar graphite. On occasion this amounted to as much as 1¾ lb. The liquid carbon disulphide frequently was saturated with sulphur. The iron occasionally was gray but more often white. Its analysis ranged between the following limits: 3.9 to 4.3% total carbon, 0.04 to 0.13% manganese, 1.33 to 0.30% silicon, 0.017 to 0.022% phosphorus and 1.25 to 0.08% sulphur.

Figure 2 shows the fracture of some iron bars cast directly into refractory molds from the furnace, and Fig. 3 the fracture of a series of tensile specimens made on bars remelted in

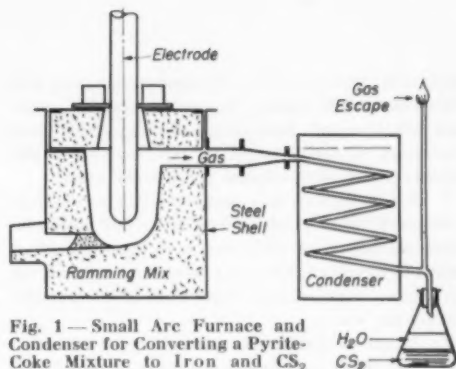


Fig. 1—Small Arc Furnace and Condenser for Converting a Pyrite-Coke Mixture to Iron and  $\text{CS}_2$

crucibles without any additions. Their analyses were 3.79 to 4.12% carbon, 0.04 to 0.07% manganese, 0.16 to 0.83% silicon, and 0.08 to 0.12% sulphur. Their ultimate tensile strength was 24,500, 26,600 and 28,400 psi. respectively. These were lowest in sulphur of the trial runs.

Further development of this process languished until 1939. At that time a second series of tests was performed with a similar furnace but large enough to take a 50-lb. charge. The 43 tests conducted during this period proceeded much as the previous ones, and were directed primarily toward obtaining an airtight furnace.

Analysis of the iron produced (without any additions) fell into the two groups: 1st Group—4.5 to 4.2% total carbon, 0.25 to 0.60% Si, 2.8 to 4.3% S; 2nd Group—4.5 to 4.2% total carbon, 0.70 to 2.22% Si, 0.94 to 1.60% S.

A third series of 40 experiments was carried out in 1941 with a tilting furnace of the same capacity, built specifically for the job. It had a single vertical electrode through the tight

Fig. 2—Fracture of Round Bars Cast From Low-Sulphur Metal Made in Furnace of Fig. 1 (Full Size)



Fig. 3—Fracture of Tensile Test Specimens Cast From Remelted Ingots Like Fig. 2



top; the pyrite-coke mixture was charged through one trunnion, the gases and  $\text{CS}_2$  were led off through the other. A tap hole was arranged so metal could be removed when the furnace was tilted almost completely over.

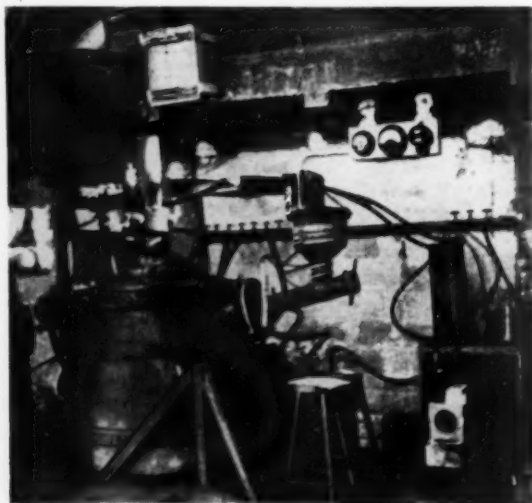
A fourth trial was made in 1943 in another factory with an existing ferro-alloy furnace suitably modified for charging and gas collecting. All of these experiments were hampered by shortages in power and other difficulties brought on by the war.

Again in 1947 a series of 45 tests was carried out with a tilting arc furnace holding 65 lb. of charge. This furnace is shown in Fig. 4. During this series all the data necessary were collected to design a larger furnace. The tightening of the electrode hole through the roof, the dust collection, and the condensation of carbon disulphide were done very satisfactorily.

The range of analyses of the iron obtained in these last experiments is 4.2 to 4.3% total carbon, 0.72 to 2.7% combined carbon, 1.20 to 0.60% Mn, 0.60 to 2.35% Si, 0.03 to 0.04% P, and 0.81 to 1.50% S. (The manganese in these irons is, of course, a result of the fact that the iron pyrite being smelted contained manganese in very considerable amounts.)

Silicon sulphide and flake graphite (the latter in amounts up to 8% of the cast iron) were found in the dust collector.

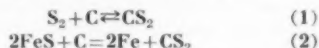
Fig. 4—Tilting Arc Furnace, 65-Lb. Capacity, Used in Final Experiments. Gases are taken off through opening at upper edge of shell and passed through dust collector and condenser; the same opening serves as a tap hole. The pyrite reduced iron contained 0.81 to 1.50% sulphur



#### CHEMICAL REACTIONS IN THE PROCESS

Pyrite ( $\text{FeS}_2$ ), heated in an oxygen-free atmosphere, partially dissociates to  $\text{FeS}$ , liberating a sulphur atom. The dissociation pressure reaches 1 atmosphere at about  $760^\circ\text{C}$ . ( $1400^\circ\text{F}$ ). At higher temperature the  $\text{FeS}$  dissociates, also, liberating the second sulphur atom. Its dissociation pressure reaches 1 atmosphere at about  $1780^\circ\text{C}$ . ( $3235^\circ\text{F}$ ).

In the presence of carbon, the following two reactions occur with the  $\text{FeS}$  and  $\text{S}$ , the above-mentioned products of dissociation.



Some carbon also dissolves in the iron.

Reaction (2) depends on the pressure of  $\text{CS}_2$ , and this in turn depends upon the dissociation of  $\text{CS}_2$ —reaction (1)—which is temperature dependent. Thus, dissociation of  $\text{FeS}_2$  begins about  $800^\circ\text{C}$ . ( $1475^\circ\text{F}$ ); near the melting point of iron, around  $1500^\circ\text{C}$ . ( $2730^\circ\text{F}$ ), the concentration of  $\text{CS}_2$  in the gaseous phase is very low. Between 800 and  $1700^\circ\text{C}$ . the sulphur vapor is surely biatomic, since dissociation of the biatomic molecule does not start until about  $2000^\circ\text{C}$ .

The process actually is controlled more by the kinetics of the reactions than by their equilibrium behavior. The desulphurization of pyrites at high temperature can therefore be explained as follows:

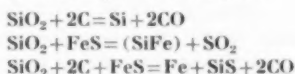
At first, the pyrite dissociates, loosing its first sulphur atom, according to the reaction  $2\text{FeS}_2 \rightleftharpoons 2\text{Fe} + \text{S}_2$ . This sulphur combines with carbon as in reaction (1). The resulting carbon disulphide is quickly driven away from the reaction zone and is eventually condensed outside the furnace. (Depending upon defects of the furnace, part of the sulphur may condense as such, avoiding any reaction with carbon.)

As the remaining iron sulphide ( $\text{FeS}$ ) melts, contact with carbon improves, and reaction (2) starts; iron separates as the heavier constituent and becomes saturated with carbon. Two liquid layers appear, the bottom one being metallic iron with carbon and sulphur in solution, and the lighter upper layer being iron sulphide ( $\text{FeS}$ ) which acts as a kind of



slag holding very small amounts of dissolved carbon. Sulphur and carbon concentrations in both layers have been determined as temperature functions by A. Norro and S. Lundquist in an article published in *Jernkontorets Annaler*, 1946, p. 188, entitled "Miscibility Gap in the Fe-S-C System Between 1300 and 2000° C."

If these reactions were the only ones to occur we could not explain why our experimental results do not agree with the sulphur concentration in the metallic phase reported by Norro and Lundquist. The difference may be due to the presence of silicon, which modifies desulphurization by a series of reactions occurring in the gaseous, slag and metallic phases. These reactions may run as follows:

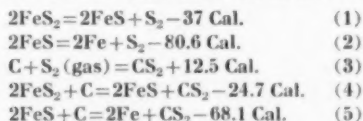


In the gaseous phase, CO and SO<sub>2</sub> must form volatile products with sulphur such as COS. (These were in fact observed by us in the various experiments.) Silicon also modifies the position of the miscibility gap in the Fe-S-C system, the equilibrium concentration of sulphur being decreased in the metallic phase.

Silicon thus plays an important role in the present process, and the simultaneous presence of lime further decreases the sulphur content in the metallic phase.

#### POWER REQUIREMENTS

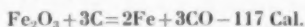
To estimate the power requirements we assume the main reactions to be as follows:



Specific heats are also as follows: FeS<sub>2</sub> = 0.22 from 0 to 1200° C.; liquid CS<sub>2</sub> = 0.242 at 18° C.; mean specific heat of iron = 0.16. Reaction (4) is complete at about 800° C.; reaction (5) starts at about 800° C. and is complete at about 1800° C.

Computing the thermal requirements from the above data, 182 Cal. are necessary to liberate 2 gram-atoms of iron.

The best way to evaluate this figure is to compare it with electric furnace reduction of ore, which is similar in operation and equipment. The reaction is



Since the products enter at room tempera-

ture and come out at 1600° C. (2900° F.), the total amount of necessary heat, calculated as in the desulphurization reaction, comes to about 194 Calories.

These theoretical figures are closely comparable in the two processes, so it is safe to estimate that the reduction of pyrites will require about as much energy as the electric furnace reduction of ore, which is about 2700 to 2800 kw-hr. per ton of iron.

#### INDUSTRIAL POSSIBILITIES

While complete knowledge of the theory of this new process needs considerable research, the technological possibilities seem firmly established by our experiments.

While our five series of experiments did not give any new knowledge of the chemical process beyond that gained at the first, they revealed many shortcomings in the equipment which were overcome. We are sure that a plant of industrial size could be constructed with equipment that is standard in present-day metallurgical and chemical industries.

Iron yields in our tests have been higher than 95%. Sixty per cent of the sulphur is recovered as carbon disulphide or sulphur; losses are attributed to leaks in the experimental equipment with consequent formation of oxysulphides, to the formation of silicon sulphide from silica in pyrite gangue and in coke ashes, to the formation of small amounts of sulphides by the other metallic elements in the pyrite, to moisture in the charge — which forms H<sub>2</sub>S and oxysulphides, and to the dusting of FeS during the early stages of FeS<sub>2</sub> dissociation.

The process appears economically feasible on the basis of present prices of raw materials and power, but such calculations are necessarily open to error. It appears safe to say, however, that it is an interesting procedure, auxiliary to the classic oxide reduction, mainly because it supplies iron directly from ore, independently of sulphuric acid plants. Any byproduct sulphur would have an immediate market under present conditions. On the other hand, the amount of CS<sub>2</sub> obtained with even a modest production of iron would exceed the present market. This could be side-stepped by burning the CS<sub>2</sub> in a limited amount of oxygen, thus producing elemental sulphur, or by developing organic products derived from CS<sub>2</sub>. The latter possibility is favored by its large free energy compared to that of hydrocarbons.

Lastly, any byproduct graphite would find a ready market in several industries.

# The "Onera" Bright Chromizing Process

**T**HE PRINCIPLE of improving the surface properties of metallic objects by diffusion is far from new; its classical examples are case hardening and nitriding. The formation of a diffusion layer rich in chromium is more recent and only beginning to come into industrial use. With the need for stainless steels increasing in every branch of industry, together with the present dearth in chromium, the future for chromizing appears promising.

Because corrosion is a surface reaction only, it can be prevented by modifying a minimum thickness of the bulk material by means of chromium diffusion. This method has the double advantage of saving up to 95% chromium, and avoiding the machining difficulties encountered with stainless and high-chromium steels.

Another advantage is that the chromium content of the surface layer can run as high as 50% to give better corrosion resistant properties than are obtained in ordinary stainless steels.

Perfectly regular, smooth, and bright layers are obtained in a single operation with the new chromizing process developed and patented at the ONERA (Office National d'Etudes et de Recherches Aeronautiques). These layers are highly resistant to corrosion caused by atmosphere, salt, nitric acid and high temperature. No layers can peel or scale off from thermal or mechanical shock, as can happen with electrolytic plating, because the surface layer is an integral part of the basis metal.

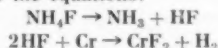
## CHROMIZING PROCESS

Many chromizing processes have been proposed but, in general, they are too complicated to be practical and produce a defective surface. In the Onera process, gaseous chromium fluoride decomposes or "cracks" at the surface of the steel parts, the chromium diffuses into the metal,

and the hydrofluoric acid recombines with chromium chips that are packed in with the steel articles.

Chromium is packed either near or in direct contact with the steel parts. A chromium fluoride-producing mixture of pulverized chromium, alumina, hydrofluoric acid and ammonium fluoride is kept separate from the work. The whole pack is heated in a reducing atmosphere under slight pressure. An alternate method consists in heating the fluoride mix separately. In either case, chromium fluoride is given off at 210 to 480° F.

according to the equations:



At about 1550° F. the vapor pressure of the chromium fluoride is high enough for the chromium to diffuse into the metal. A true gaseous cementation of chromium with a chromiferous gas is thus obtained. In one hour at 2010° F., chromium will give a 0.1-mm. (0.004-in.) surface layer that is both homogeneous and ductile. Layers up to 1 mm. (0.040 in.) in thickness have been built up.

Average hardness of these surface layers runs around Vickers 200. The chromium content, as determined by spectrographic analysis and successive electrolytic polishings, was found to exceed 50% at the surface of the material and

decrease gradually toward the inside.

With high-carbon steels and cast irons, the carbon reacts with the chromium and diffuses toward the surface to give

a continuous layer of chromium carbide. Although the layer formed after 4 hr. at 1920° F. is only 0.03 mm. (0.0012 in.) thick, it has a hardness of Vickers 800 to 1000. Special steels containing "carbide formers" (titanium, manganese and molybdenum) have been prepared in Germany for use with the B.D.S. chromizing process. The Onera process gives as good results with ordinary steels as with these special steels.

Such refractory metals as tungsten or molybdenum require higher temperatures, 2730 to 2910° F., because the diffusion coefficient of chromium is very low in these metals. Refractory metal powders can be chromized in the gaseous phase between 1920 and 2010° F.

The chromizing mixture does not deteriorate during use, although a small quantity of fluoruous compound must be added between operations. Ammonium chloride and other ammonium halides

**By Bernard Jousset**  
President and Director General  
Societe Parisienne de Cementation  
Paris, France

are not recommended for this process as they pit the steel. These pits are probably due to volatile iron chloride produced at the beginning of the process. On the other hand, ammonium fluoride gives a very thin protective layer of iron fluoride, which is not volatile at all and is reduced by hydrogen at high temperatures. Lastly, chromium fluoride has the advantage over ammonium chloride of being nonhygroscopic.

#### FIELDS OF APPLICATION

Chromium diffusion layers obtained by gaseous chromizing are corrosion resistant. Chromized specimens treated for a few hours at 1920 to 2012° F. are not pitted after several weeks of intermittent immersion in salt water. Onera chromizing produces a decorative surface suitable for such applications as marine fittings and motor car trim.

The following properties of Onera chromizing on steel and cast iron indicate its scope of applications:

1. Chromized steel may be subjected to severe shaping operations without the diffused layer scaling off or splitting.

2. Chromized steel can be electropolished or electroplated with chromium.

3. Chromized layers on mild steel are highly wear resistant. The low hardness obtained with low-carbon steels can be improved with a complementary nitriding.

4. Chromized layers on high-carbon steels and cast irons are less ductile but are extremely hard because of the large amounts of chromium carbide found in the case.

5. Chromizing temperatures may warp or deform the parts being treated, which is a limitation to the process. The mechanical properties of the metal may also be altered during chromizing, thereby necessitating a subsequent heat treatment.

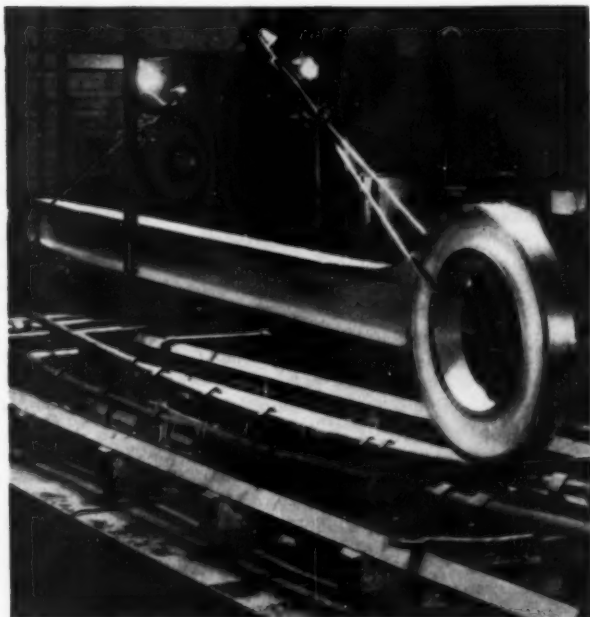
Both superficial oxidation and chromium diffusion into the interior limit the maximum temperature at which chromized layers can be used. Dry tests in flue gases show that the lifetime of homogeneous 0.1 to 0.15-mm. (0.004 to 0.006-in.) chromized layers is practically unlimited up to roughly 1380° F. At 1470 to 1560° F., they can be used for several hundred hours, but at 1830 to 2010° F. the layers disappear after a few hours. Thermal shock resistance is excellent

because of the gradual transition in properties from layer to core.

Chromizing can also be used to protect nickel, cobalt or alloys such as Hastelloy (which contains no chromium) against scaling at temperatures to 1650° F.

Scale resistance can be improved by producing binary or ternary layers containing (in addition to chromium) silicon, aluminum or tungsten. These elements, or their compounds, are added to the fluoride mix where they react with the chromium halide to give their corresponding halides which take part in the gaseous cementation. These additions, made under the same operating conditions, improve the composition and thickness of the layers, as well as increase the maximum scale-resistant temperature.

Resistance to liquid nitric acid attack is excellent, while against attack by nitrous oxides at high temperature is very good. The 0.004 to 0.006-in. thick layers will resist more than 1 hr. exposure to these gases at 1830° F.



Chromium Plating a Locomotive 12-Ft. Main Rod. One of the biggest plating jobs tried, temperature of work and bath were controlled to give uniform coating. Courtesy Timken Roller Bearing Co.

# Bessemer Steel

## Low in Nitrogen and Phosphorus

**W**HILE FOR MANY APPLICATIONS, such as screw machine parts, rail, structural steel and concrete reinforcement, basic bessemer steel is just as suitable as openhearth, it cannot compete with the latter in uses requiring high ductility—for example, deep drawing.

For over half a century European steel-makers have tried to overcome this disadvantage by reducing its nitrogen and phosphorus content. This can be done by carefully controlling the temperature, blowing pressure, and time of operation. By such methods, Belgian works regularly produce basic bessemer with nitrogen as low as 0.007 to 0.012% and phosphorus as low as 0.050%.

To reduce the nitrogen further in a bottom-blown vessel, the metal may be blown with oxygen-enriched air or other gases. The present paper will give a brief account of this process and the results obtained.

The development work was done in three Liege steelworks: S. A. Ougrée-Marihay, S. A. Métallurgique d'Espérance-Longdoz, and S. A. John Cockerill, and included experiments with the converters themselves, extensive chemical analyses and physical tests of the steels produced and a statistical study on more than 400 test blows—that is, on more than 8000 tons of metal.

### Tests With Enriched Air—

The first tests were undertaken to define the optimum conditions for eliminating nitrogen by blowing with oxygen. To this end, the amount of oxygen in the blast or the charge, the nature, the quantity and the time of the additions were varied.

1. With an air enriched to

30% oxygen (which seems to be economic optimum) and with nothing but scrap additions for cooling the steel bath, nitrogen was reduced 20% from the value obtained with normal practice—that is, from 0.0100% (normal) to 0.0083% with enriched blast.

2. With the same air enrichment (enough oxygen added to bring it to 30%), but cooling the bath with ore additions instead of scrap, nitrogen was lowered 40%—that is, to 0.0060%.

3. Nitrogen content in the steel can be reduced by charging or blowing a substance such as a carbonate, which decomposes with heat and evolves a gas, thus lowering the partial pressure of nitrogen in the blast. Ordinary limestone is most suitable for such an addition. Besides being cheap, it decomposes to sulphur-free CaO. Furthermore, the CO<sub>2</sub> evolved partially decomposes to CO and O<sub>2</sub>, and this oxygen helps shorten the conversion time.

To study the effect of limestone, a number of blows were made with ordinary air and with increasing amounts of limestone, in which the amount of burned lime and scrap was reduced in the same proportion that limestone was added. When these results

were plotted and an average curve drawn, it was found that little or no nitrogen would be eliminated unless more than 40 lb. of limestone per short ton of pig iron was charged; 100 lb. of limestone reduced the normal nitrogen by one quarter; one half elimination required about 300 lb. limestone per ton of pig iron. (It may be assumed that, in these runs, 40 lb. of limestone per ton of pig was lost by dusting, delayed action, or other causes.)

While the CO<sub>2</sub> from CaCO<sub>3</sub> acts chiefly by reducing the partial pressure of N<sub>2</sub> in the blast, this action is completely independent of other

**By Pierre Coheur**

**Director of Metallurgical Dept.**

**University of Liege**

**Liege, Belgium**

**Director, Liege Section**

**National Bureau of Metallurgical Research**

**Table I—Blows With Steam-Oxygen-Air**

BLOW	H <sub>2</sub> O-O <sub>2</sub> MIXTURE	O <sub>2</sub> CONSUMPTION*	SCRAP ADDITION†
4 min., 30% O <sub>2</sub> air;	{ 63% O <sub>2</sub> ; 37% H <sub>2</sub> O 70% O <sub>2</sub> ; 30% H <sub>2</sub> O	1350 to 1475	34 to 38% 75%
4 min., H <sub>2</sub> O-O <sub>2</sub> mixture added			
30% O <sub>2</sub> air plus	{ 63% O <sub>2</sub> ; 37% H <sub>2</sub> O 70% O <sub>2</sub> ; 30% H <sub>2</sub> O	1765 1860	None 60%
H <sub>2</sub> O-O <sub>2</sub> mixture			

\*Cu.ft. per short ton pig iron blown; total for entire blow.

†Based on pig iron charged to converter.

details of the process, such as enriching the air and making ore additions. Consequently, definite advantages should be obtained by combining all of these methods. Experiments confirm this. With air enriched 30%, and with ore (no scrap) plus 2600 lb. of limestone charged to the converter instead of 1650 lb. of lime, nitrogen in the resulting steel was 35% below that remaining after a blow with enriched air and ore only. This means that basic bessemer steel has been produced with a nitrogen percentage of 0.0040%, and this is comparable to openhearth steels.

**Phosphorus** can also be reduced 30% by enriching the air in oxygen and using ore and limestone. Normal basic bessemer contains 0.050% P; the revised process makes steel with 0.032% P. Any further reduction involves a double slag process, requiring a higher temperature at the end of the blow, and this automatically adds 0.0010 to 0.0020% to the nitrogen in the resulting steel.

**Production Rate**—An important economic gain is possible. Oxygen-enriched air means that additional scrap or ore can be melted, and conversion time can be cut by about 40%. Increase in production of a 15,000-kg. converter can average 20 to 25% when air enriched to 30% oxygen is used.

These important advantages were predicted on theoretical grounds more than 25 years ago and have since been experimentally verified.

#### TESTS WITH STEAM AND OXYGEN MIXTURES

If the very lowest nitrogen is desired in the steel, other methods must be used, such as blowing with mixtures of oxygen and nitrogen-free gases. Superheated steam, which some steel-makers have used for controlling the temperature during conversion, is the most economical gas for dilution.

The first tests using steam and oxygen immediately showed a reduction in the ejection losses, reduced the nitrogen content to about 0.0020%, and cut the conversion time 40 to 50%. Furthermore, scrap additions could be

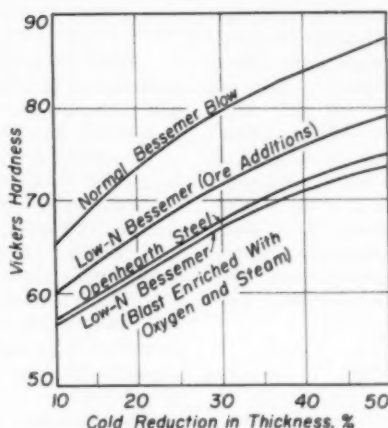


Fig. 1—Normal Bessemer Steel Hardens Considerably More, for a Given Amount of Cold Reduction, Than Low-Nitrogen Steels

increased approximately in proportion to the ratio of steam to oxygen.

Numerous tests led to two preferred processing methods: The first attempts to reduce the oxygen costs utilized the steam-oxygen-air mixture only during its most effective period—that is, from the middle of the decarburizing period to the end of the conversion. The first half of the blow is best done with air enriched to 30%  $O_2$ , which allows appreciable scrap and ore additions.

The second method attempts to reduce ejection losses by starting the steam-oxygen-air mixture as soon as metal is spit from the converter mouth, or by using the mixture from the very start of the blow. This permits the charging of pig iron that could not be blown with ordinary air because it would then fail to develop the necessary heat. Ultimately it may be possible to operate the blast furnace so as to obtain pig iron richer in silicon and lower in sulphur.

Steam and oxygen mixtures thus offer

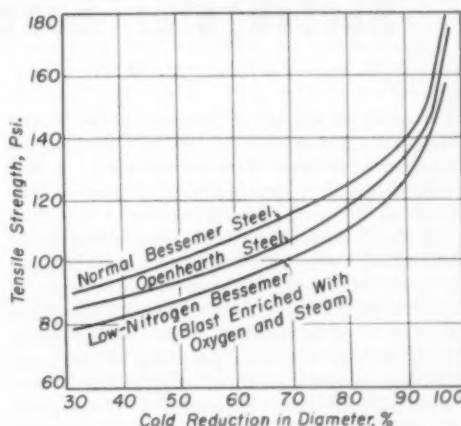


Fig. 2—Tensile Strength of Bars or Wires of Equal Carbon Content After Drastic Reduction in Diameter by Drawing Through Dies. Openhearth steel is intermediate in hardness between normal basic bessemer steel and low-nitrogen steel made by special bessemer process



exceptional economic possibilities, not only in the basic bessemer process but also in the acid.

The phosphorus in steel produced by either method is of the order of 0.035% — that is, about the same as obtained in the tests with enriched air. But, in contrast with the blows using enriched air, a second slag can be used if the vessel is blown with steam and oxygen mixtures without increasing nitrogen in the resulting steel. Basic bessemer steels have been produced without difficulty containing about 0.0020% nitrogen and 0.020% phosphorus. The slags have lower iron contents, indicating less oxidation of the metal.

#### PHYSICAL PROPERTIES

These steels have been tested in ways too numerous to describe here at length. Improvement in ductility, which was the original object of this research, is obtained. Figures 1 and 2 on p. 79 show that steels produced by the methods described briefly in this article have properties comparable to or better than values for normal openhearth steels.

#### CONCLUSIONS

These tests indicate that blowing with enriched air or a mixture of steam and oxygen will produce basic bessemer steels with exceptionally low nitrogen and phosphorus.

Ductility of these steels is excellent — at least equal to normal openhearth steel.

From the point of view of economies, these methods of blowing offer outstanding possibilities. Besides insuring a product of excellent quality, they increase the production capacity of standard bottom-blown converters. Further, they convert pig irons of compositions which heretofore were either difficult to blow in the conventional way or which did not generate enough heat.

In conclusion, it must be said that these results are in large part due to the splendid teamwork of Messrs. Danbersy, de Radiquès, and Peeters of the S. A. Métallurgique d'Espérance-Longdoz; Messrs. Marbais, Hotot and Poverman of the S. A. d'Ougrée-Marihay, Messrs. Van Campenhout, Nepper and Dor of the S. A. John Cockerill.

## Drawing Limits for Rectangular Boxes

**B**ILLIONS OF POUNDS of strip are press formed each year throughout the world. Despite the tremendous volume of metal fabricated in this way, there is no systematic knowledge of the limits of the many press operations. It is true that the drawing of circular cups is reasonably well understood. In addition to a large number of facts obtained from extensive theoretical and experimental research on this operation, there are two rules of thumb that have been successfully used by shop-men for many years: (a) Circular cups can be drawn successfully in production from most commercial sheet metals if the ratio of the blank diameter to cup diameter is less than two, and (b) if the height of the circular cup does not exceed its diameter.

On the other hand, information on the limits for cupping

rectangular shells — an operation commonly encountered in production — is virtually nonexistent. The present report gives some data on the subject in an effort to correct this situation. It confines itself to a study of the geometric variables involved in drawing rectangular boxes of normal deep drawing grade of aluminum sheet.

Such variables as metal properties, heat treatment, hold-down pressures, press speed, or lubricant which affect the drawing limits have been held constant.

**Procedure** — The experiments were carried out on 99.5% pure aluminum strip at two thicknesses: 0.8 and 1.0 mm. (0.031 and 0.039 in.). The material had been hot rolled to 4.0 mm. (0.157 in.), cold rolled to final thickness, and annealed at 350° C. (660° F.) for 1 hr. Using Fukui's cupping test,\* the maximum blank diameter that could be drawn without tears was

\*In the Fukui test a round blank is cupped through 60° conical die using a spherical punch with diameter of 17.46 mm. (0.68 in.) and a die having a diameter of 19.95 mm. (0.78 in.). The nose radius of the "cylindrical" punch is 4 mm. (0.157 in.) and that of the spherical punch is equal to half the punch diameter.

**By Toshisade Ishikawa**  
Nippon Aluminum Mfg. Co.  
Osaka, Japan

2.48 and 2.45 times the cup diameter for the cylindrical and spherical punches, respectively. The ordinary or commercial grade aluminum strip gives values of 2.44 to 2.50 in this same test; therefore the present stock can be regarded as normal deep drawing material.

The principal dimensions of the punches and dies for the rectangular boxes were chosen to fall within common practice. These dimensions (shown in Fig. 1) include corner radius of the punch  $C$ , the bottom radius of the punch  $B$ , the bottom radius of the corner of the punch  $D$ , the shoulder radius of the die  $D_s$ , the radius at the corner of the die  $D_c$ , the width of the punch  $W$  and the length of the punch  $L$ . Their actual values in these experiments are listed in Table I. (Note that in most instances  $C$  is greater than  $B$ , so that the vertical projection of the center of radius  $C$  falls upon the flat bottom of the box.) The clearance maintained between the punch and die was between 1.0 and 1.1 times the original thickness of the sheet.

The press we used was a crank drawing press with a cam-actuated blank holder. Thus, blanks were held rigidly and changes in thickness of cup-wall were less than would have occurred if the blank were held down by springs or rubber blocks. Press capacity was 55 tons, the working stroke was 19½ in. and the press

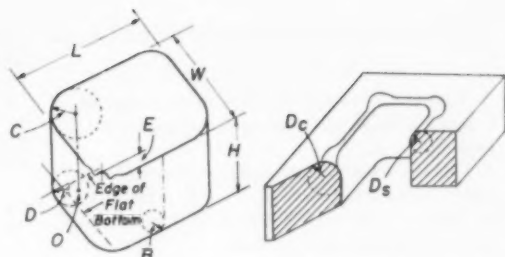
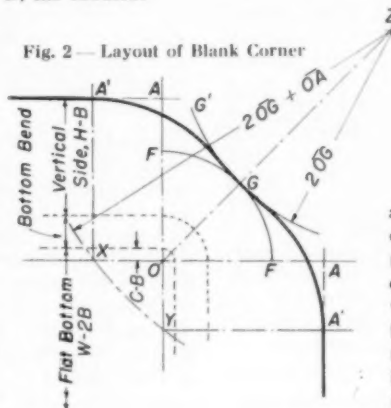


Fig. 1—Left, Dimensions of Punch (and Resulting Shell); Right, Dimensions of Die.  $H$  is the total height of cup; the height of the vertical side is  $H-B$

Fig. 2—Layout of Blank Corner



operated at 20 strokes per min. The lubricant used in the study was a mineral oil mixture.

The shape of the blank's corner is quite important in drawing rectangular boxes; it not only affects the cupping limit (depth of cup), but determines the evenness of the box height and top edge. The shape adopted by us was thought to be well adapted to large variations in the corner radius of the punch. ( $C$  varied between 11 and 40 mm.—that is,  $\frac{7}{16}$  to  $1\frac{5}{8}$  in., as shown in Table I.)

The method of laying out the blank profile is shown in Fig. 2. Point  $O$  is the vertical projection of the center of the corner radius  $C$ .  $OG$  should theoretically be the radius of a circular blank which would form into a cylindrical shell of  $2C$  diameter, domed bottom of  $D$  radius and total height of  $H$  (assuming the surface area of the blank equals the surface area of the resulting shell). This radius  $OG$  can be computed from the formula  $OG^2 = 2C(H-D) + C^2 + C(\pi-2)D + (3-\pi)D^2$  when  $C$  is equal to or greater than  $D$ .

The dimension so computed proved to be 5 to 10% deficient. That is to say, when blanks were laid out with computed dimension  $OG$ , there was a deficiency of metal at the top corner of the box, rather than a slight ear as shown at  $E$ , Fig. 1. Consequently, after the first trials the computed  $OG$  was increased by 5% for cups with  $C = 11$  to 15 mm. (Table I), and 10% for cups with  $C = 30$  to 40 mm.  $OG$  (a line at 45°) was extended for the center of curve  $GG'$ ; its radius was  $2OG$ .

Table I—Dimensions (in Mm.) of the Punches and Dies Sketched in Fig. 1

COMBINATION	PUNCH (SHELL)					DIE	
	C	W	L	B	D	$D_s$	$D_c$
No. 1	11.0*	99.0	99.0	9.0	9.0	5.0	7.5
2	11.2*	106.4	171.4	9.2	9.2	5.0	7.5
3	12.0*	136.0	176.0	10	10	5.0	7.5
4	15.0*	126.0	184.0	15	15	5.0	7.5
5	40.0*	205.0	435.0	15	15	5.0	7.5
6	30.0†	60.0	105.0	10	10	8.0	8.0
7	30.0†	60.0	75.0	10	10	8.0	8.0
8	30.0*	100.0	100.0	12.5	12.5	5.0	8.0
9	30.0*	100.0	120.0	12.5	12.5	5.0	7.5
10	30.0*	100.0	150.0	12.5	12.5	5.0	7.5

\*Tools of these dimensions used with 0.8-mm. (0.031-in.) sheet.

†Tools of these dimensions used with 1.0-mm. (0.039-in.) sheet.

$\overline{OA}$  was similarly computed from the formula

$$\overline{OA} = H + C - \left(2 - \frac{\pi}{2}\right) B$$

Centers X and Y for the curves tangent at A' were located by striking a radius  $2\overline{OG} + \overline{OA}$  from center Z.

Blanks laid out by these principles were made progressively larger—that is, with increasing values of H (total height)—for each punch-and-die combination of Table I. The limit of deep drawing for these studies was the occurrence of tearing of the box at or near the bottom.

The results of our cupping tests may be plotted in various ways. In Fig. 3 the vertical

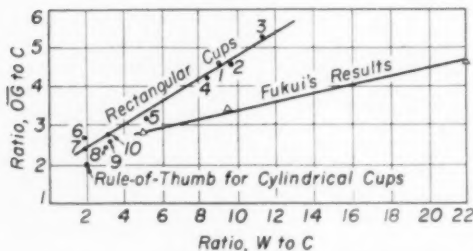


Fig. 3—Cupping Limit in Relation to Radius at Corners (Intersections of Sides)

ordinates are  $\overline{OG}/C$ , the ratio between the radii at the corner of the blank and at the corner of the punch; the horizontal ordinates are  $W/C$ , the ratio between the width of box and the corner radius of the punch. A circular cup can be described as one wherein  $W/C = 2$ ; a solid circle is shown in Fig. 3 and 4 at  $X = 2$ ,  $Y = 2$  which corresponds to the rule-of-thumb limiting value for such a shape.

The location of two of our experimental points for punch-and-die combinations (Table I) have the same abscissas but show higher cupping limits than those indicated for the rough rule. These cups were not circular cups but rectangular boxes with cylindrical bottoms—that is, the box's width was equal to  $2C$ , but the length was greater than  $2C$ . It is possible that the higher cupping limit for these combinations No. 6 and 7 may be due in part to the lateral flow of metal from the circular ends into the sides of the box. The general increase in cupping limit as the ratio of box width to punch

corner radius increases is undoubtedly due to the same effect.

Some results of Fukui, Takeyana, and Yoshida are also plotted in this graph. The

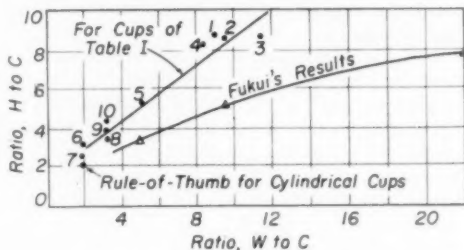


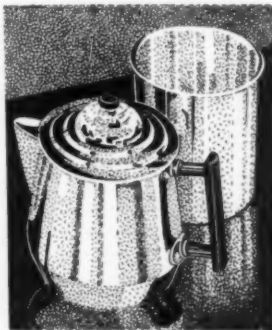
Fig. 4—Cupping Limit as a Function of Height and Width of Square Box

corner-bottom radius  $D$  of their punch, and the corner-shoulder radius  $D_s$  of their die were much smaller (being about 5 mm. or 0.2 in.) than those used in the present experiments. The different lines on Fig. 3 indicate that these radii are also determinative variables for the cupping limit for rectangular boxes.

Figure 4 plots the results in a different manner. Here the ratio of the successful box height  $H$  to the corner radius of the punch  $C$  is plotted as a function of the ratio of the box width  $W$  to the corner radius of the punch  $C$ . Inasmuch as the denominators of these two ratios are the same, they can be canceled out, whence it is seen that the present results could be described most simply by saying that the maximum attainable height of the box is about equal to the width of the box. This would appear to be a simple extension of the approximate rule for cylindrical cups, namely, that its height cannot exceed its diameter.

However, the results of Fukui and his co-workers plotted on the same figure warn against any such hasty conclusion, and again emphasize the importance of the corner-bottom radius on the punch and the corner-shoulder radius on both punch and die.

It should be pointed out that these data involving box height are not accurate because of the inevitable waviness of the top edge of the box; however, they will provide a reasonably adequate guide for approximate layout work. ☐



# High Permeability "Sendust" Powder Ring Cores

"SENDUST" is a high permeability alloy discovered by Honda, Masumoto and Yamamoto in course of an investigation of the magnetic properties of the iron-rich iron-silicon-aluminum alloys.

Use of the alloy in powder form for loading coil cores seems to have been developed over the period 1937-1940, but little was known of this activity until the visits of United States and Australian scientific missions to Japan in late 1945 and early 1946, respectively. It was then found that, owing to the extreme shortage of nickel, Sendust had been used to the virtual exclusion of Permalloy for voice and carrier frequency applications. The material is also reported to have been used to a limited extent in Germany toward the end of the war where it was produced by Siemens and Halske who, it is claimed, preferred it to high nickel-iron alloys.

If the scanty post-war references to Sendust are any indication, little or no interest has been shown in the material, except possibly in Russia. The few writers who have mentioned it at all are inclined to dismiss it from further consideration on the grounds that the composition is very critical, that the permeability of the finished cores is appreciably lower than of the high nickel alloys, and that the loss coefficients are appreciably higher; the only factor mentioned in its favor is that, being a brittle alloy, it is readily crushed to powder.

With nickel in reasonably free supply, Sendust may never be an attractive substitute for high nickel alloys; on the basis of present indications, however, nickel is likely to become increasingly restricted to critical applications for which no satisfactory substitutes are available and the author believes that now is the time to explore the potentialities of any promising substitutes. Sendust is considered to fall within

this category of an alternate material.

The reader is asked to bear in mind that the work on which this note is based is purely exploratory and would not be reported at this stage but for the incentive provided by the Metals Congress. The purpose of this note is to draw attention to what appears to be a neglected opportunity for saving nickel.

## PROPERTIES OF SENDUST

According to Masumoto's description in his report "On a New Alloy 'Sendust' and Its Magnetic and Electrical Properties" (published in Anniversary Volume of the Science Reports of the Tohoku Imperial University, Series 1, 1936), the initial permeability of the iron-rich Fe-Si-Al alloys reaches a sharp peak value of 35,000 at 9.6% Si and 5.4% Al; the peak value of 160,000 for maximum permeability is reached at 9.7% Si and 6.2% Al (see Fig. 1 and 2, reproduced from Masumoto's paper). Hysteresis loss of the alloy in bulk form was quoted as 28 ergs per cc. per cycle at a peak flux density of 5000 gauss and resistivity at 81.2 microhm-cm., as compared with 73 ergs per cc. and 16 microhm-cm. for Permalloy.

A striking feature of the curves relating permeability with composition is the extremely rapid fall in both  $\mu_0$  and  $\mu_{max}$  with departure from optimum composition. At first sight, it would seem that the alloy composition might be too critical for practical application. In powder cores, however, the

effective permeability (due to insulating material between the particles) is only a very small fraction of the intrinsic permeability of the starting material, and it is a matter of experience that intrinsic permeabilities much lower than optimum are still capable of giving powder cores with acceptable characteristics. An initial permeability of 10,000 is understood to be accepted in Japanese works practice as being very satisfactory; rejection limit is believed to be 6000.

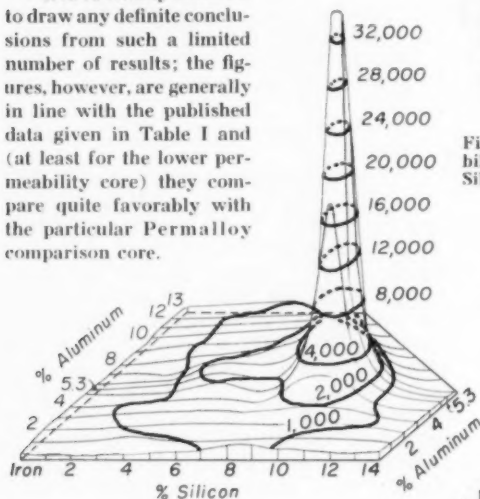
The only information available in Australia regarding typical properties of powder cores is that contained in the Australian Scientific Mission to Japan, Report No. J 261, translation of a paper by Yamamoto. The values shown in Table I are from this report.

Australian results on Japanese ring cores are even more scanty, only two cores having been available for test; the results on these

**By E. G. Thurlby**  
Superintending Metallurgist  
Defense Research Laboratories  
Melbourne, Australia

samples are shown in Table II, in which has been included for comparison the corresponding figures for two randomly selected Permalloy cores of similar dimensions.

It is obviously unsound to draw any definite conclusions from such a limited number of results; the figures, however, are generally in line with the published data given in Table I and (at least for the lower permeability core) they compare quite favorably with the particular Permalloy comparison core.



EXPERIMENTAL WORK

The work described falls in the preliminary stage of an investigation to establish a manufacturing technique for Sendust powder cores, having a permeability within the range of 80 to 90 coupled with acceptable loss factors, for use in loading coils for voice frequencies and transmission network applications generally.

It was clear at the outset that the factors affecting the properties of finished cores were numerous and interconnected. Therefore, it would not be reasonable to investigate each variable independently and in detail until a preliminary survey had been made and a procedure established that would give cores with properties at least within sight of the objective.

For convenience, the order of presenting the description of this survey follows the sequence of the manufacturing operations involved in making the cores. Because of the short-cut methods adopted, the results obtained in the early stages were often affected by more than one variable and, as they could easily be more confusing than helpful to the reader, they have been omitted. Detailed results\* have been given for work carried out toward the end of the sur-

\*Hysteresis and eddy current loss coefficients. Residual loss coefficients have not yet been determined.

vey, at which time the general pattern of behavior became clearer and it was feasible to limit the number of variables under investigation at one time.

**Melting**—Japanese practice is to melt in quantities up to 1000 lb. in an induction melting furnace of 200 or 300 kva. capacity. The iron is melted first, quickly brought to 1600° C., and a lime slag cover is established by the simultaneous

Fig. 1 — Initial Permeability of Iron-Rich Iron-Silicon-Aluminum Alloys

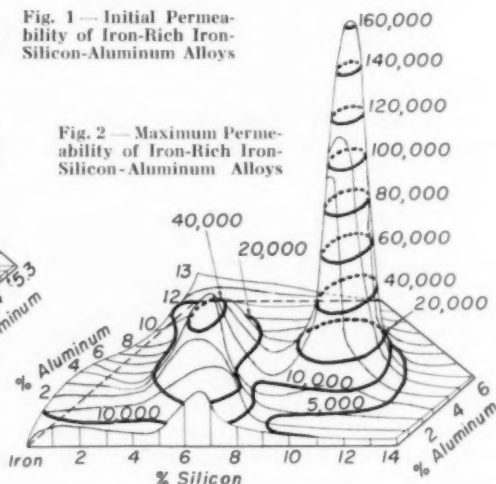


Fig. 2 — Maximum Permeability of Iron-Rich Iron-Silicon-Aluminum Alloys

addition of lime with the silicon, which is added progressively in small quantities. The aluminum is added as soon as possible, and is plunged to the bottom of the melt to minimize oxidation losses. Total time from melting of the iron to completion of the additions should not exceed

Table I — Typical Properties of Sendust Ring Cores

PERMEABILITY	HYSTERESIS LOSS COEFFICIENT	EDDY CURRENT LOSS COEFFICIENT
13	4.5	0.14
20	11.0	0.13
31	14.3	0.07
36	16.0	0.08
50	14.3	0.06
56	35.4	0.13
56	21.4	0.16
60	35.4	0.19
64	57.0	0.28
70	42.7	0.18
72	57.0	0.47
79	67.6	0.42
80	71.2	0.57
89	62.3	0.45



**Table II — Test Results on Sendust and Permalloy Cores**

CORE	PERMEABILITY	HYSTERESIS LOSS* COEFFICIENT	EDDY CURRENT* LOSS COEFFICIENT
Sendust	53	30	0.53
Sendust	66	75	1.28
Permalloy	55	35	0.61
Permalloy	92	65	1.61

\*All of these tests were carried out by the Research Laboratories of the Postmaster-General's Department.

15 min.; optimum time is about 5 min. As a control, a ring is cast and tested magnetically; extra aluminum is added if the permeability is low. The iron used is an electrolytic grade; the purity of the silicon and aluminum does not appear in any reports available to the author.

Our initial melts (which were of 2 to 3 lb.) confirmed the difficulties of melting the alloy on a small scale without undue losses of both silicon and aluminum. As was expected, melting in vacuum was quite successful but was discarded as being a method not likely to be acceptable to Australian industry. The method finally adopted was to melt under hydrogen, using an inverted crucible as a cover, followed by degassing for 2 to 3 min. with argon. Losses of silicon and aluminum were negligible.

Raw materials for the experimental melts were ingot iron (0.03% C, 0.014% P, 0.028% S, 0.12% Mn, with traces of Ni, Cr, Cu and Co) commercial silicon (97% grade) and commercial aluminum (99%). In the early melts, permeabilities as low as 1000 were obtained, even with vacuum melting. Impurities in the silicon (particularly Ca, present to the extent of 0.33%) were at first suspected, but it was later found that, owing to fine gas porosity, the permeability figures obtained for the test rings were fictitiously low. A useful result of this work was to show that calcium, at least in amounts up to approximately 0.3% in the silicon, could be tolerated. The effect of other impurities has not been investigated for the reason that, from the inception of melting under hydrogen followed by degassing with argon, no difficulty has been encountered in obtaining permeability figures of 10,000 and over.

The fact that it was necessary to resort to a method of melting other than in air for the small laboratory melts (which in no case exceeded 10 lb.) does not necessarily mean that air melting will not be satisfactory under production conditions; this will depend to a very large extent on the size of melts and the rate at which melting can be carried out.

**Crushing and Ball Milling** — Japanese practice is to break castings into 2-in. lumps and anneal for 3 hr. at 1000° C.; the lumps are then crushed in a stamp battery followed by ball milling. The powder is finally separated into two grades — (a) 200 to 300-mesh for permeabilities of 80 to 90 and (b) less than 300-mesh for lower permeability cores, such as those used for carrier and radio frequency applications.

The only difficulty encountered in this stage of the process was excessive contamination of the powder when using porcelain balls. With flint balls, there was still some contamination from the walls of the mill; the particles from this source, however, were very fine and were almost completely removed in the subsequent decantation to remove excess water prior to drying of the powder.

The screen mesh analysis of powder ball milled for 18 hr. averaged 1 to 10% retained on 200-mesh, 60 to 70% between 200 and 300-mesh, and 25 to 35% through 300-mesh. The Japanese practice of using the 200 to 300-mesh for cores with a permeability of 80 to 90 has been used for most cores made to date, but from recent work it would seem that incorporation of all powder finer than 200-mesh would be permissible.

**Annealing Prior to Pressing** — As a result of ball-milling, the powder is heavily cold worked, in which condition the permeability is low. One function of annealing at this stage is to restore the permeability; another is to produce an oxide film on the particles for the purpose of insulating each particle from its neighbors, thereby reducing the eddy current losses.

If our information is correct, Japanese practice is to carry out the annealing in two stages: (a) 2 hr. at 900° C. in vacuo to restore the permeability, (b) followed by 30 min. at 600° C. with a small amount of air admitted to provide the oxide film.

The results of tests on trial cores made from powder annealed as above were most disappointing, particularly in regard to eddy current losses, which immediately threw suspicion on the insulation between the particles. In the hope that deficiencies in the oxide film could be compensated by other means, a batch of rings was made using one per cent of an inert filler (bentonite) in addition to the normal amount of sodium silicate-boric acid binder. The bentonite gave some improvement in interparticle insulation, but only at the expense of permeability, which was in any case much lower than was desired.

At this stage of the work, virtually no experi-

ence had been obtained to guide us in selection of optimum conditions in the later stages of bonding, pressing and baking. With a view to eliminating as many of these variables as possible, small cylindrical compacts were prepared without any binder or filler; resistance measurements were made to evaluate the insulating properties of the films without the added complication of binding or filling materials.

Although the results of these tests were not very consistent they were sufficiently informative to show that no satisfactory insulating films could be produced on any powder that had been heated to 900° C., irrespective of the degree of vacuum (down to 0.1 mm. of mercury), or of the rate of cooling; indeed, the mere heating to 900° C. seemed to destroy any prospect of producing a satisfactory film by any subsequent heat treatment. Pending investigation, it is thought that oxide films produced at 900° C. are either too thick and too easily damaged in the subsequent pressing for the present purpose, or that loss of aluminum at this temperature is sufficient to impair the film-forming properties in any subsequent heat treatment.

The annealing conditions necessary to give good insulation together with minimum film thickness have not been explored fully. The best films obtained to date have been produced by a single anneal of 2 hr. at 600° C. in vacuum (0.1 mm. mercury), but it may well be that improved results could be obtained at some higher or lower temperature.

**Inorganic Binder**—The following amounts of sodium silicate and boric acid are understood to be used in Japan as binding agents for cores with permeabilities ranging from 20 to 80.

INITIAL PERMEABILITY	% SODIUM SILICATE	% BORIC ACID
80	0.6	0.2
50	1.5	0.5
20 to 30	4.0	1.3

As the number of variables being explored is already very large, it is proposed to leave any investigational work on binding that may be necessary until optimum conditions for the other variables have been found. In the meantime, the quantities of binder constituents appropriate to cores with permeability 80 are being used for all experimental cores.

**Pressing**—The rings we have been using have a 50.5-mm. external, 30-mm. internal diameter, and a 10-mm. thickness for two rings—these being chosen to correspond with the particular type

of commercial Permalloy core being used as the standard of performance. Because of the limited capacity of our press, it has been necessary, until very recently, to limit pressing to 224,000 psi.; only a few rings have been pressed at 257,000 psi. It is understood that Japanese procedure after addition of the binder is to partially dry the powder until it is sticky and to press as follows:

INITIAL PERMEABILITY	COMPACTING PRESSURE, PSI.
80	257-291,000
50	190,000
20 to 30	101,000

Sendust powder is both hard and angular, characteristics which result in poor flow and poor packing. The incidence of cracking was rather high initially, but was reduced considerably by careful leveling of the charged powder and the provision of a taper (0.04 in. per in.) at the exit end of the die. Thorough drying of the powder and slow pressing of the compacts out of the die are other measures that have helped to reduce cracking.

**Baking**—The final operation of baking serves the dual purpose of hardening the binder and of producing a marked improvement in magnetic properties (higher permeability and lower hysteresis losses consequent on relief of stresses resulting from pressing). Obviously, there will be an optimum baking temperature below which recovery of the magnetic properties will not be as complete and above which some disruption of the bond is to be expected, with an increase in spacing between the particles, and consequent reduction in permeability.

The information obtained from Japan was that baking was carried out by heating in air

Table III—Effect of Particle Size Distribution\*

CORE SAMPLE	PARTICLE SIZE DISTRIBUTION, %			$\mu$ (a)	h (b)	$e_c$ (c)
	150 TO 200-MESH	200 TO 300-MESH	300-MESH			
58	100	—	—	70	60	1.6
54	—	100	—	76	45	1.0
55	—	100	—	77	70	1.2
56	—	100	—	75	85	1.3
60	—	50	50	74	65	0.9
61 (d)	—	83	17	79	55	1.1
59 (e)	6.7	65.0	28.3	78	50	1.2
57	—	—	100	72	55	0.8

\*Initial permeability 12,000; compacting pressure 224,000 psi.; baking treatment 1 hr. at 700° C., cool at 60° C. per hr. to 600° C., air cool below 600° C. (a) Permeability. (b) Hysteresis loss coefficient of core. (c) Eddy current loss coefficient of core. (d) Proportions calculated to give closest packing. (e) Powder as obtained from ball mill without sieving.

Table IV — Effect of Baking Treatment\*

CORE SAMPLE	BAKING		COOLING		$\mu$ (a)	h (b)	$e_c$ (c)
	TEMP., °C.	HOURS	TO 600° C.	BELOW 600°			
75	600	1	Air	Air	89	56	0.79
71 (d)	700	1	Air	Air	91	71	1.0
73	700	4	Air	Air	83	42	0.89
72 (d)	700	1	60° C./hr.	Air	85	63	0.93
74	700	4	60° C./hr.	Air	84	43	0.82
76	800	1	Air	Air	78	41	1.04
77	800	1	60° C./hr.	Air	75	43	1.10
78	900	1	Air	Air	69	45	1.45
79	900	1	60° C./hr.	Air	66	59	1.94

\*Initial permeability 30,000; particle size — all particles finer than 200-mesh; compacting pressure 257,000 psi. (a) Permeability. (b) Hysteresis loss coefficient of core. (c) Eddy current loss coefficient of core. (d) Two cores processed identically with No. 71 and 72, but made from alloy with permeability 12,000, gave slightly lower hysteresis loss coefficients (44 and 49) and slightly higher eddy current losses (1.16 for each); permeability was 87.

for 30 min. at 580 to 630° C. It was also stated that the baking operation was a critical part of the process and that the remaining details would not be disclosed.

Our own work would tentatively confirm the suitability of baking at approximately 600° C., but a more detailed survey in the range 500 to 700° C. has yet to be made. As will be seen from the statement of the present position, which follows, the magnetic properties (with the exception of hysteresis losses) deteriorate progressively as the baking temperature is increased from 600 to 900° C. Rate of cooling seems to be unimportant (effects of air and slow cooling shown in Fig. 3), at least within the temperature range we investigated.

#### PRESENT POSITION

The present position of the investigation can be judged from the results listed in Tables III and IV which give, respectively, the effect of particle size distribution and baking treatment. The following factors were common to most of the cores reported on in the forementioned tables:

RAW MATERIALS: Ingot iron, commercial silicon (purified), commercial aluminum.

MELTING: Under hydrogen, degassed with argon.

ANNEALING OF POWDER: 2 hr. at 600° C. in vacuo (0.1 mm. of mercury).

BINDER: Sodium silicate 0.6%, boric acid 0.2%.

The effect of baking treatment (Table IV) on the magnetic properties of the cores is much more readily appreciated from the curves shown in Fig. 3. In assessing the

capabilities of the material, results given for baking temperatures over 700° C. obviously should be disregarded as being too far removed from optimum.

While these results should be regarded only as a very useful starting point for a more detailed investigation, there can be little doubt that cores made under suitable conditions, as they are known at present, would form an acceptable substitute for Permalloy cores of 80 to 90 permeability should the nickel position render such a substitution necessary. As seen at present, the main

difficulties that may occur in production would pertain to pressing of the cores.

**Acknowledgment**—This paper, which is based on work done by N. J. Kelly and K. Bailey, Defense Research Laboratories, is published by permission of Chief Scientist, Department of Supply, Australia. Testing of the cores was done by Research Laboratories of the Postmaster-General's Department, to whom due acknowledgment is made.

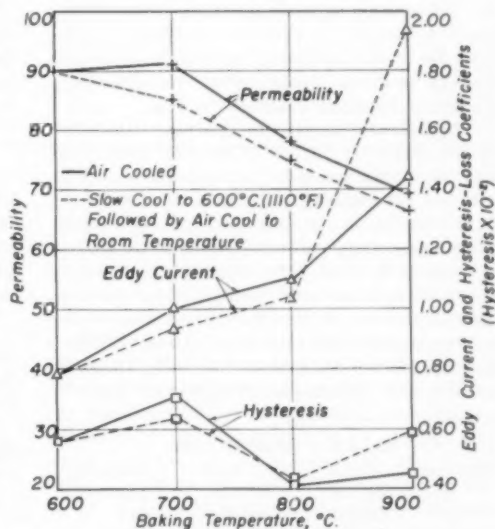


Fig. 3 — Effect of Baking Treatment on Magnetic Properties of Cores Pressed at 257,000 Psi.

# Continuous Heat Treatment of Aluminum Alloy Strip

CONTINUOUS HEAT TREATMENT of aluminum alloy strip has occupied the attention of engineers for a number of years. Although more or less satisfactory solutions have been proposed and adopted, the problem of quenching strips of duralumin 24S, 24S Alclad, and 17S remains rather acute since the development of tandem rolling mills for rolling long coils of wide strip.

In 1939 the Central Society for Light Alloys decided to install at Issoire, France, a modern plant which would include tandem mills for hot and cold rolling of wide aluminum alloy strip. It was therefore essential for us to perfect a continuous method of heat treating the product. Although several tests had been made on various methods for solution heat treatment in the various plants of our group, the time necessary to dissolve the microconstituents continued to create a major problem in the design of continuous equipment for large-scale production.

**Preliminary Tests**—In order to determine the necessary conditions to be met, systematic tests were undertaken in the laboratories. The principal results of these tests are as follows:

To determine the minimum time of heating before hardening, 0.040-in. sheets were heated in a salt bath for various times up to 16 min., then quenched in water and tested in tension. The composition of the sheet tested was of the duralumin type: 0.45 to 0.49% Fe, 0.69 to 0.70% Si, 4.07 to 4.11% Cu, 0.81 to 0.82% Mg and 0.65 to 0.67% Mn. Results are tabulated in Table I.

Table I—Effect of Time

MINUTES	YIELD	ULTIMATE	ELONGATION
1	31,100	61,600	24.0%
2	34,850	59,000	23.2
4	34,150	60,700	24.0
8	35,300	61,600	24.1
16	35,600	61,700	23.8

Next, the effect of cold work (its amount) was studied by rolling a 0.32-in. plate down to 0.158, 0.079 and 0.035 in. respectively. As a consequence, cold reductions of 105, 310, and 810% were secured. Some of the sheets were homogenized at 925° F. (495° C.) for 10 hr., followed by air cooling, while others were not homogenized. These sheets were then heated in a salt bath for various times, from 15 sec.

to 20 min., then quenched in water. After four days of natural aging, the mechanical properties listed in Table II were obtained.

From these data one finds:

1. That the homogenization treatment was sensitive to certain factors which influence the rate of solution.

2. That a desired minimum value of the tensile strength, namely, 57,000 psi., was obtained after 3 min. of heating for 4-mm. (0.158-in.)

sheet—that is, a 105% reduction; after 2 min. of heating for 2-mm. (0.079-in.) sheet—that is, a 310% reduction; or after 1 min. of heating for 0.9-mm. (0.035-in.) sheet—that is, an 810% reduction.

3. The optimum properties secured after four days of natural aging were 8 min. of heating for 0.158-in. sheet (reduced 105%), 5 min. of heating for 0.079-in. sheet (reduced 310%), and 3 min. of heating for 0.035-in. sheet (reduced 810%).

These differences in heating times were not commensurate with the difference in thickness. In fact, the coefficient of heat transmission between the salt bath and duralumin sheet is 0.011, and the heating time  $T$  in seconds necessary to bring a sheet of thickness  $t$  in millimeters up to temperature is

$$T = 12.4 t$$

which works out to be 12 sec., for 0.9-mm. (0.035-in.) sheet and 50 sec. for 4-mm. (0.158-in.) sheet.

It was thought, therefore, that the observed difference was due to the varying amounts of cold reduction.

**The influence of cold reduction before hard-**

\*Translated by Paul S. Methé, research engineer, Aluminum Research Laboratories, New Kensington, Pa.

ening was then studied on duralumin sheets, 1 mm. thick (0.040 in.), having been reduced cold 0%, 100%, and 700%, respectively, and also 3.8 mm. (0.150 in.) thick having been reduced cold 0% and 100%.

Properties listed in Table III (p. 90) were obtained after various times of heating in the salt bath, followed by a water quench and a natural aging period of seven days.

From these mechanical tests, one can easily see the influence of cold rolling on the rate of solution of constituents:

1. For 1.0-mm. (0.040-in.) sheets cold rolled 700%, a tensile strength of 58,400 psi. was

optimum properties could be acquired after 1 min. of heating at 925° F. (495° C.) if the sheet had previously been cold rolled 400% or more. For lighter reductions, 2 min. at heat was required.

Similar results were noted in a series of tests performed on 24S strips, 0.040 in. thick, 40 in. wide, in the laboratory of the United Engineering and Foundry Co.'s plant at New Castle, Pa., with heating times in salt bath ranging from 15 sec. to 20 min. Satisfactory mechanical properties were obtained with at least 30 sec. at heat, fast quenching, and five days of natural aging.

Table II—Effect of Cold Reduction on Homogenization

TIME (MINUTES)	REDUCED 105%			REDUCED 310%			REDUCED 810%		
	YIELD	ULTIMATE	ELONG.	YIELD	ULTIMATE	ELONG.	YIELD	ULTIMATE	ELONG.
Aluminum Alloy Sheet Not Homogenized									
1/4	10,100	31,850	14.2	23,750	45,250	21.1	29,300	50,750	20.4
1/2	19,340	44,400	18.5	27,300	50,500	22.0	33,000	54,100	19.6
1	21,200	47,250	18.4	30,150	54,100	20.7	32,900	57,600	22.2
2	26,750	54,500	19.4	33,800	59,000	23.1	36,900	60,800	22.1
3	25,500	57,900	21.4	35,200	61,600	22.4	40,000	63,600	22.0
5	30,700	60,100	22.3	37,000	63,000	25.0	38,700	63,400	23.2
8	32,150	62,550	23.1	37,700	64,000	24.8	39,250	65,150	22.1
12	33,400	62,900	22.7	38,800	64,800	23.5	39,000	65,500	23.7
20	34,000	62,900	24.6	40,000	65,550	24.7	39,800	66,100	23.7
Homogenized Aluminum Alloy Sheet									
1/4				18,500	42,600	20.7	26,750	50,600	21.4
1/2				24,300	50,600	21.5	29,900	55,900	31.3
1				29,900	55,000	19.5	34,100	59,500	21.8
2				33,900	60,200	22.4	38,200	62,800	22.1
3				35,300	61,900	25.0	37,700	63,600	24.1
5				37,800	64,100	23.9	37,800	63,900	24.5
8				37,700	64,000	22.6	39,000	65,450	22.7
12				38,700	64,500	24.2	38,600	65,250	23.2
20				39,100	65,100	24.4	39,100	65,500	26.1

secured after 1 min. heating; whereas 3 min. was required to develop that strength in sheets not cold rolled.

2. Optimum values of tensile strength, tensile yield strength, and elongation were obtained for 1.0-mm. sheets cold rolled 700% after 2 to 3 min. of heating, whereas sheets not cold rolled required 5 min.

In order for the 3.8-mm. (0.158-in.) sheet to have the necessary mechanical properties, the following times were established: 5 min. at temperature if not cold rolled, and 2 to 3 min. for sheets having 100% cold reduction.

Similar tests were made on 1.0-mm. duralumin sheet that had been cold rolled intermediate amounts between the 100 and 700% shown in Table III, and from them it was concluded that

#### MINIMUM RATE OF QUENCH

To get some information on the minimum quenching speed that would be necessary some tests were conducted on 1.0-mm. (0.040-in.) duralumin strips, 500 mm. (19.7 in.) wide, heated to 500°C (930° F.) and held at temperature for 20 min. To quench, the strip was passed through a turbulent water spray. These tests have shown (a) that the sheets were deformed very little by quenching in the water spray and (b) that the minimum rate of passage through the water spray should be 1.5 meters per min. (approximately 5 ft. per min.). The properties obtained by such a heat treatment were then comparable to those given to the metal by a rapid quench in cold water.



# COMMERCIAL HEAT TREATING SCHEDULE

The conclusions from these different tests show that the continuous quenching of aluminum alloy strip of the duralumin type was possible under the following conditions:

Approximate time at temperature: 2 min. for 1.0-mm. (0.040-in.) sheet; 4 min. for 4.0-mm. (0.158-in.) sheet.

Minimum rate of passage through the quench: 1.50 m. per min. (approximately 5 ft. per min.).

One can therefore see that it is theoretically possible to set up a continuous schedule using a conventional furnace that only permits the heating of wide but relatively short strip, but because the strip must travel at a relatively high speed

sions with the United Engineering & Foundry Co. in Pittsburgh concerning new rolling mills for the plant at Isoire. (In 1939, the Society had ordered similar equipment but, as a consequence of the war, the mills were not delivered. Subsequently, Reynolds Metals Co. acquired these mills and installed them at Lister Hill, Ala.)

Our friends of the United Engineering & Foundry Co. indicated that they also regarded continuous heat treating as a necessary complement to the rolling mill. M. D. Stone, manager of their development department, had previously studied the induction heating of steel for the continuous tin plating process, and already had envisioned its application to aluminum. With this confirmation of common ideas, M. Bresson of the Central Society for Light Alloys investi-

Table III — Effect of Cold Reduction Before Hardening

TIME (MINUTES)	NO REDUCTION			100% REDUCTION			700% REDUCTION		
	YIELD	ULTIMATE	ELONG.	YIELD	ULTIMATE	ELONG.	YIELD	ULTIMATE	ELONG.
Duralumin Sheets 1.0 Mm. (0.040 In.) Thick									
1	26,000	50,500	20.0	29,850	55,500	20.0	35,600	58,400	20.0
2	32,700	57,000	17.0	32,700	57,600	19.0	37,000	59,700	22.0
3	32,700	58,300	19.5	32,700	60,500	19.0	38,400	62,500	20.0
4	35,600	57,600	15.5	35,600	60,500	19.0	38,400	62,500	22.0
5	37,000	61,200	19.0	35,600	61,100	20.0	38,400	61,100	20.0
6	34,200	61,200	19.0	34,200	61,100	19.0	38,400	61,100	19.0
Duralumin Sheets 3.8 Mm. (0.150 In.) Thick									
1	24,200	48,400	20.0	27,500	54,000	20.0			
2	27,000	57,000	18.0	31,300	57,600	22.0			
3	32,700	58,400	19.0	35,600	61,900	23.0			
4	34,100	59,700	20.0	35,600	61,100	22.0			
5	32,700	59,700	19.0	34,100	61,100	21.0			
6	34,100	61,100	19.0	35,600	62,600	22.0			
7	35,600	61,100	19.0	35,600	61,100	22.0			
8	35,600	61,100	22.0	35,600	62,600	22.0			

for the process to be economically feasible, rapid heating to the desired temperature would be difficult to insure.

During the last war, we were greatly hampered in conducting our tests because of the working conditions in France and the difficulty of procuring the necessary materials. However, we undertook different experiments on the heating of strip by electric currents. Also, we entered into an agreement with La Compagnie De Telegraphie Sans Fil, Paris, to study high-frequency induction heating. Still, nothing was accomplished on this project prior to the liberation of France at the close of 1944.

In February 1945, when normal trade relationships between the United States and France were again possible, our Society started discus-

gated details of the process in complete cooperation with the U. S. firm. The latter, in addition to the ideas of Dr. Stone, had the necessary mechanical experience to design the necessary auxiliary equipment.

A test furnace was constructed in the American plant at New Castle, Pa., where the first tests had taken place. The general outline of the furnace installation is described as follows:

## CONTINUOUS HEAT TREATING FURNACE

The continuous furnace is large enough for aluminum strip up to 56 in. wide and 0.010 to 0.080 in. thick. Speed is a function of the thickness, and varies from 0 to 50 ft. per min. (15 m. per min.).

Solution heat treatment is assured by an induction coil of 1875 kva. power, single phase, 60 cycles, 440 volts, which quickly preheats the strip to approximately the solution heat treating temperature. This requires less than a minute. Next the strip passes into a stabilizing furnace in which the proper temperature is maintained. This stabilizing furnace is electrically heated and the atmosphere is continuously circulated in order to bring the strip up to the exact solution heat treating temperature in a uniform manner, and to achieve this temperature as quickly as possible. Upon leaving the furnace, the strip is quenched by water sprays.

The various components of the complete unit are shown in Fig. 1. The quenching bath is located immediately below the furnace, and consists of a series of water sprays. Furnace tightness (and premature air cooling before quenching) is insured by immersing the exit door below the water level.

A warm air dryer immediately

regulation of  $\pm 0.5$  in. On each half of the coil are fixed edge protectors to avoid overheating the edge of the strip, and these protectors are similarly cooled.

An arrangement of photo-electric cells adjusts the edge protectors according to the various widths of strip (30 to 56 in.). By other photo-electric cells, the lateral movement of the strip is automatically followed to  $\pm 2$  in.

#### EDGE PROTECTORS

The edge protectors originally had guide rolls at their base which supported the edges of the strip and held it in a central position. These guide rolls have since been discarded because

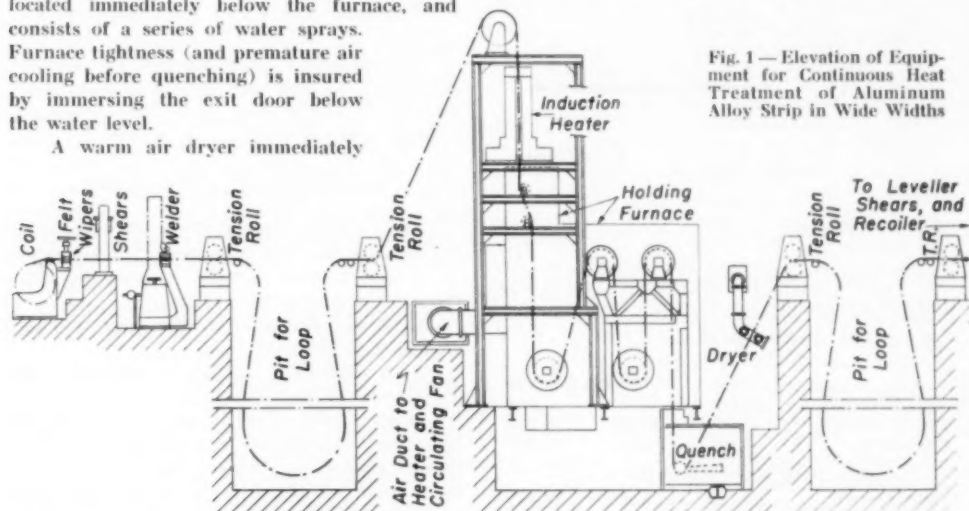


Fig. 1—Elevation of Equipment for Continuous Heat Treatment of Aluminum Alloy Strip in Wide Widths

follows the water bath. Located above and below the moving strip are longitudinal tubes through which hot air is blown. This system proved to be quite efficient; it requires a 20-hp. motor to drive the blower.

Aside from usual motors and their automatic control the electrical equipment includes devices for regulating the current going into the induction heating coils. Incoming power is supplied at 440 volts, 60 cycles, to an auto-transformer and a voltage regulator.

The induction coil heats the strip with a transverse flux of 1875 kva., 490 volts, 60 cycles. A battery of condensers of 1950 kva., 575 volts, 60 cycles, single phase, paralleling the induction core, correct for power factor. The induction coil is water cooled. The gap between poles, for the passage of strip, is 3 in., with a possible

they scratched and would even tear the strip.

A section of the edge protectors as now installed is sketched in Fig. 2. They are made of copper and are water cooled. The interior insulation is a cement mixed with asbestos fiber. The overlapping distance can be varied from 0 to 4 in.

With speed constant at 12 ft. per min. and with various rates of induction heating (variable intensities) it was noted that the temperature from center to side of strip varied considerably with different positions of the edge protectors. In service, temperature will be checked at a point intermediate between sides and center by a thermocouple placed on the end of a long lever. The thermocouple will ride the moving strip intermittently until the reading is made.

Several temperature surveys were made which

gave the results of Fig. 3. If the protectors were not used an important difference in temperature was registered from edge toward center of strip, amounting to as much as 60° C. (110° F.). On the other hand, when the overlap was as much as 4 in., the reverse situation occurred and the edge was as much as 100° C. (180° F.) cooler than the center.

Figure 3 shows, however, that with an overlap of 2 in. this differential no longer exists. When speed was 18 ft. per min., the induction coil regulated for 650° F. (345° C.) center temperature, and the air furnace maintained at 635 to

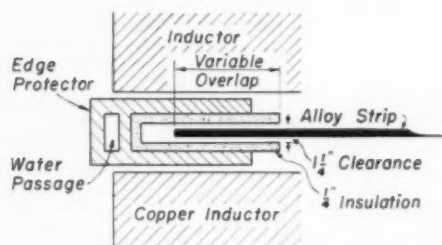


Fig. 2 — Cross Section of Movable Edge Protectors

650° F. (335 to 345° C.) the strip is nearly uniform in properties. For example:

#### Strip as Rolled

	EDGE	8 IN. FROM EDGE	CENTER
Yield strength	38,700	38,500	39,000
Tensile strength	40,000	40,250	40,250
Elongation	3.4%	3.4%	3.4%

#### After Heat Treatment

	EDGE	8 IN. FROM EDGE	CENTER
Yield strength	18,100	15,950	16,800
Tensile strength	33,700	30,750	32,000
Elongation	19.9%	20.7%	21.7%

Other tests indicated that when the inductor coils were spaced to less than 3 1/4 in. a high power factor was achieved. When 24S strip, 0.040 in. thick and 40 in. wide, is put through the equipment (coils spaced at 3 in. and edge protectors overlapping 2 in.) at 18 ft. per min. the strip is heated to 880° F. (470° C.) with 2800 amp. of current. At 30 ft. per min. about 3000 amp. is required.

Coils of 24S Alclad treated in the furnace were sampled and tested in the heat treated and aged condition. Results are given in Table IV.

The higher speeds of 30 ft. per min. gave unsatisfactory properties, while sheet treated at 19 ft. per min. yielded

desirable properties. It is felt, however, that this low speed is not the maximum possible. Tests at New Castle were terminated after the supply of strip was exhausted.

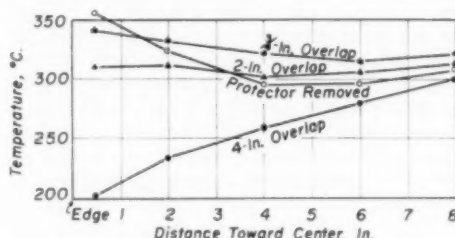


Fig. 3 — Temperature Variation in Strip for Four Positions of Edge Protectors

Nevertheless, these first results were encouraging and the furnace has been shipped to France. At this writing (June 1951) it has not yet been received and put into action.

#### CONCLUSIONS FROM AMERICAN TESTS

The following important matters were determined from the tests conducted at New Castle:

1. The correct method to pass the strip through the heat treating furnace.
2. Proper regulation of the speed and the voltage of the furnace.
3. A practicable method of measuring the temperature of the moving strip.

Minor modifications in the furnace and its operation will doubtless be made when the furnace is erected in France. We believe it will mark a distinct advancement in the economical production of aluminum alloy strip and coiled strip-sheet.

Table IV — 24S Alclad Strip, Heat Treated in Continuous Furnace and Aged

POSITION	YIELD	ULTIMATE	ELONGATION
Speed 19 Ft. per Min.; 2400 Amp.			
Right edge	35,000 to 38,600	57,500 to 60,500	12.9 to 16.0
Center	36,100 to 40,250	58,100 to 60,900	15.4 to 19.2
Left edge	36,700 to 39,700	57,400 to 59,100	14.5 to 18.5
Speed 19 Ft. per Min.; 2450 Amp.			
Right edge	35,600 to 40,800	58,000 to 59,900	15.0 to 19.0
Center	37,300 to 41,500	58,600 to 60,500	15.6 to 18.6
Left edge	38,000 to 40,300	57,000 to 59,300	15.0 to 18.4
Speed 30 Ft. per Min.; 3000 Amp.			
Right edge	31,600 to 36,100	53,000 to 55,000	13.6 to 17.3
Center	32,000 to 36,700	53,000 to 56,600	12.6 to 18.4
Left edge	31,400 to 34,400	51,400 to 54,000	13.7 to 16.7

# Iron and Steel Industry in India

**P**ROSPECTS of the Indian iron and steel industry are very encouraging, as there are great long-term economic possibilities in the country with its huge population and potential market. Compared to a per-capita consumption of 1180 lb. in the United States, 232 lb. in Russia, 65 lb. in Hungary, 470 lb. in Australia, our consumption of 8 lb. per capita shows our glaring industrial backwardness. India emerged from the war with a clearer realization of the possibilities and implications of industrialization, and it may be interesting to note that 1,100,000 tons of steel consumed in prewar 1939 was less than that of 1914 (1,300,000 tons), and very much less than the 1,700,000 tons consumed in 1929. By 1948 production had only grown to 1,250,000 tons of ingots. This shows that our utilization of steel does not increase even with the increase in population.

Historically, the soil is fertile. Archeologists generally place the birth of the iron age in India about 1400 to 1500 B.C. The historical remains indicate a fairly highly developed iron culture in ancient times. Hyderabad and southern Madras are considered by many to have been the centers of production of Wootz steel, famous for centuries, carried to Damascus and Toledo and being the material from which the famous swords of these cities were made. The iron pillar near Delhi is supposed to be wrought during the reign of Samudragupta about 330 A.D. This pillar was probably made from large blooms, smelted in primitive furnaces similar to those used by the *agarias* (indigenous smelters) still practicing their craft over a wide area in the provinces of Bihar and Orissa (see the sketch map, Fig. 1).

Unfortunately, Indian iron smelters never overcame certain definite limitations, and showed little tendency to progress. They got no further than the export of large quantities of Wootz steel, and the fashioning of splendid weapons in Europe rather than at home was due to the fact that western scientific advances left them untouched.

The first attempt in India to establish indus-

try upon western lines was made in 1831 by Josiah Marshall. The work was started at Porto Novo on the coast about 125 miles south of Madras. His small furnace was capable of yielding about 40 tons of charcoal pig iron per week. The blowing engine was driven by bullocks whenever the 4-hp. steam engine could not work. Fifty years

after its inception the company was dissolved.

The first iron and steel works in India which ever attained even a moderate measure of success was established near Barakar, northwest of Calcutta, in 1875. The undertaking suffered many reverses at the outset, but in 1889 it passed into the hands of the Bengal Iron & Steel Co. which is now amalgamated with the Indian Iron & Steel Co. Construction of Tata's large steel plant was started in 1907 and the first iron made in 1911.

**Present Development**—There are four major producers of iron and steel in India; among them the Tata Iron & Steel Co. is the biggest producer, making in 1939 60% of the pig iron and more than 90% of the steel. The present capacity for finished steel in India is 1,200,000 tons, the main producers and their equipment being listed below. In addition there are a number of small producers, Government Ordnance Factories, and re-rolling mills, but their production is very small compared to the major producers.

Tata Iron & Steel Co., Ltd., at Jamshedpur: Coke ovens; four blast furnaces from 650 to 1100 tons daily capacity (annual capacity 1,300,000 tons of basic and foundry iron, plus

75,000 tons ferromanganese); eight openhearth of 60 to 125 tons, and two 5½-ton electric in No. 1 shop (annual capacity 375,000 tons of steel ingots); three 25-ton acid converters and three 250-ton tilting basic openhearth in No. 2 shop (annual capacity 700,000 tons of steel ingots); one 25-ton acid converter and two 50-ton tilting openhearth in No. 3 shop (annual capacity 40,000 tons of acid and 20,000 tons of basic steel). Rolling mills for structurals, rails, sleepers and track accessories, wheels, tires, axles, 97-in. plate, merchant shapes, wire and wire products, tool-steel and alloy steel.

Steel Corp. of Bengal, Ltd., at Hirapur, in connection with Indian Iron & Steel Co., Ltd., at Hirapur and Kulti: Four blast furnaces making 775,000 tons annually of basic and foundry iron; two 25-ton converters, one 90-ton openhearth, three 225-ton tilting openhearth (annual capac-

By **P. E. Mehta** ©  
Technical Officer  
Tata Industries, Ltd.  
Bombay, India

ity 250,000 tons of basic steel ingots and castings); rolling mills for structurals, rails and track accessories, sheet, merchant bars, spring steel and toolsteel.

Mysore Iron & Steel Works at Bhadravati. Wood distillation plant; one 80-ton charcoal blast furnace; two 25-ton basic openhearth and one 25-ton electric furnace; rolling mill for small sections; pipe foundry. This plant also produces about 5000 tons of ferrosilicon annually.

**Raw Materials**—India is endowed by nature with almost all the raw materials required, and thus produces, next to Australia, the cheapest pig iron and steel in the world. A comparison of prices is shown in the following tabulation.

Table 1—Price Comparison, as of Mid-1950

COMMODITY	U. S.*	U. K.*	AUSTRALIA*	INDIA
Foundry pig iron	846.50	833.65	822.10	818.70
Structural steel	76.15	56.50	38.90	52.40
Merchant bars	77.30	62.45	38.90	48.60
Plates	78.40	58.05	41.15	57.47
Rails	84.00	60.65	42.20	48.80
Wire rods	86.25	59.10	41.35	87.90
Re-rolling billets	59.35	47.10	35.80	40.00

\*Figures from *Fortune* for November 1950.

Raw materials (located approximately within the circle on the map) are also responsible for the location of our industry in the Bengal-Bihar-Orissa region. The ease with which rich raw materials can be mined and assembled is the main reason for the low costs of production, and it would be unsound to establish new steel plants away from these sources, since India unfortunately does not enjoy the economics of extensive internal water transport.

#### IRON ORE

India possesses perhaps the largest reserves of high-grade iron ore in the world, as well as huge amounts of low-grade ores.

The richest iron ore field in India is situated in Bihar and Orissa. The first discovery was made by the late P. N. Bose in 1904, and the Gorumahisani Iron Mines of the Tata Iron & Steel Co. were opened in 1910. There are quite a few large areas in this field which have not been worked. Most of the developmental work was done around the 1920's.

Other deposits in this area are vanadium bearing titaniferous magnetites.

The only deposit of high-phosphorus ore is in Bengal. It is poor in iron content (35 to

45%). Most of the easily available ore in this locality has been worked out.

Iron ores are widely distributed in Mysore and Sandur. The Mysore Iron & Steel Works gets its ore from the Bababudan hills. Massive hematites and limonites are known to exist but they have not been properly explored because of their distance from the railhead.

The ores in Madras, where the industry started, are mainly magnetic, low in iron (30 to 40%) and very high in silica. They can easily be concentrated to 55% Fe, but we have not sufficient data on such processes on even a pilot plant scale to get an idea about the economics of their recovery and use.

In Hyderabad the richest occurrence is in the Bailadila range in Bastar district. The ores are mainly hematites. The Bastar deposits are inaccessible at present and far away from any coal fields, but are of high grade, containing 58 to 66% Fe.

Since mineral deposits are not worked on modern lines in India, reserves are not estimated carefully as in Western countries. As high-grade ore is plentiful, no reserves of different grades and categories have been blocked out. However, estimated tonnage may be stated as follows:

STATE	RESERVES	QUALITY
Bihar and Orissa	10,000,000,000	58 to 68%
Mysore and Sandur	330,000,000	33 to 68
Bastar	2,500,000,000	58 to 66

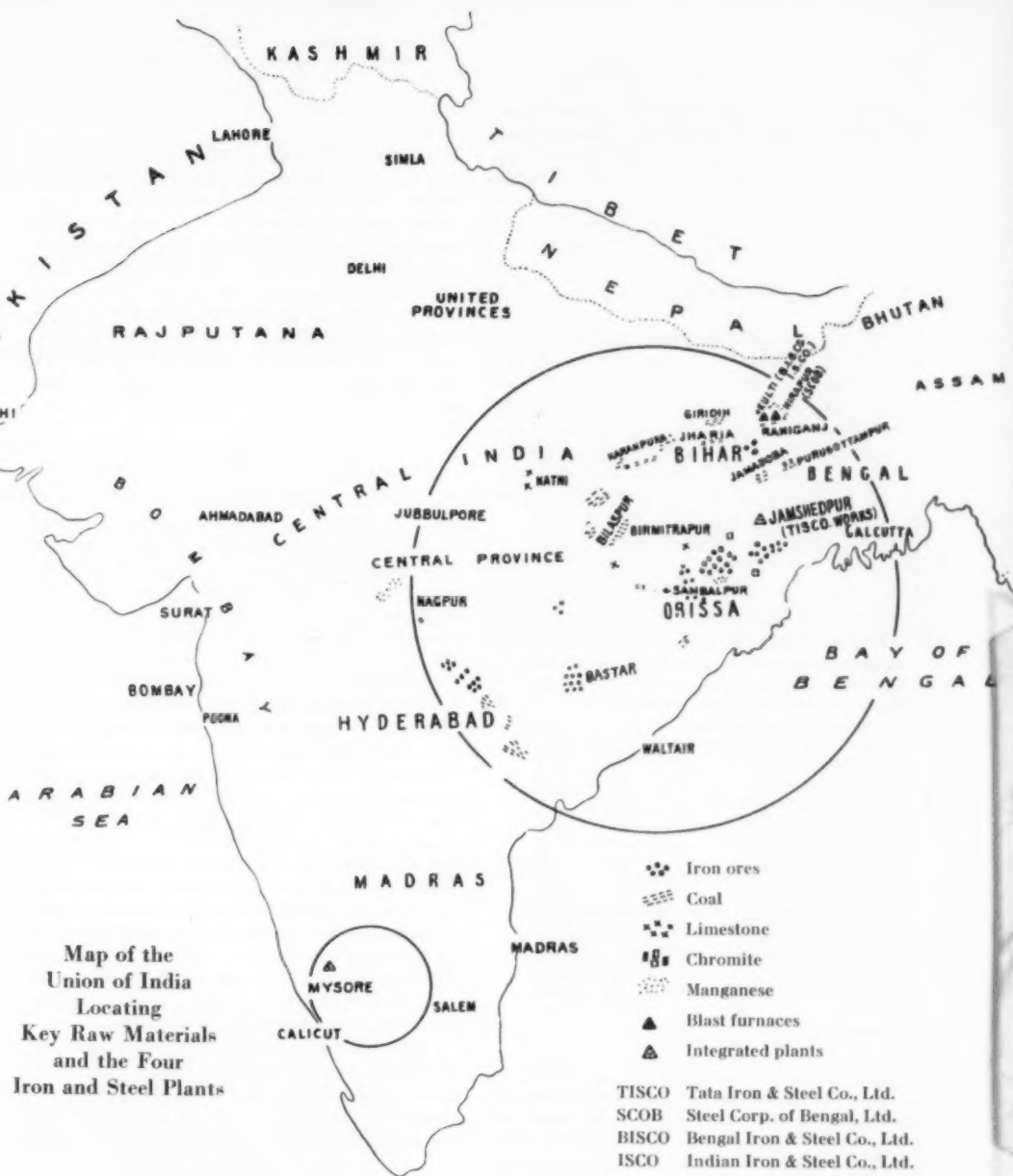
Obviously these figures are rather astronomical when measured in terms of India's present mining activities. They would doubtless supply the present American industry for a century.

**Flux**—Although flux is a very important blast furnace raw material, the required quality is not easily available near our steel centers. Furthermore, much must be used; despite a high-grade ore, our coke averages 22.7% ash.

For blast furnace use the maximum limit for silica and alumina in limestone is 5%, whereas in the openhearth it is 4%. Though there are several limestone deposits near the iron and coal fields, few come up to the quality required. Major producers draw their flux from Gangpur district in Orissa, located from 120 to 200 miles from the major producers. Like the steel industry in the United States, ours is not blessed with a near supply of flux.

Perhaps the only mineral required in which we are deficient is fluorspar. Some is known but its quantity and quality is not high enough to work economically.





#### BLAST FURNACE PRACTICE

P. E. Cavanagh's articles in *Metal Progress* for April and May, 1950, demonstrate that the location of major iron and steel units is determined more by the availability of high-grade coking coal than good iron ore. More important is the size of the market and the area which can be reached at a competitive price. We agree

that, for purely economic reasons, blast furnaces also may be located close to the source of fuel and to the market, rather than to the ore.

As far as furnace practice is concerned, one of the trends is to increase the volume of air blown into the furnace per minute per unit of area. Present Indian practice is to work at the maximum allowable pressure. A great deal of work has been done to determine whether it

is practical to select ore in a certain size range for uniform rate of reduction. This simple change will save coke and increase production, and corresponds with modern trends in blast furnace technique to increase the rate and uniformity of contact between the reducing gas and ore.

#### NOTES ON FINANCES AND LABOR

The total invested capital in the Indian iron and steel industry, including re-rollers and smelting units at the Government ordnance factories, is about 300 million rupees. Valuation at the present day totals from 1200 to 1500 million rupees (\$250,000,000 to \$300,000,000).

The industry employs over 72,000 persons, and the average wage paid is the highest of any industry in the country.

Some idea as to the apportionment of income can be had from the following figures from the British Iron & Steel Federation and corresponding ones from the 1949 annual report of Tata Iron & Steel Co., Ltd.

##### Apportionment of Income in Great Britain

Raw materials, fuel and services	60%
Wages, salaries, national insurance, holidays and pensions	26
General expenses, including rents and insurance	2
Delivery charges	4
Retained in business for depreciation	3
Taxation	4
Dividends	1
Total	100%

##### Apportionment of Income in India

Raw materials and services	32.47%
Wages, salaries and administration	38.41
Freight	14.39
Retained in business for reserves	2.14
Taxation	7.75
Dividends	4.84
Total	100.00%

Economic conditions in India have changed rapidly during the last decade. The myth of cheap Indian labor is gone. Before World War II, top management of our heavy industries took the general attitude the mechanization had to be done slowly; otherwise it would throw out of employment many hundreds of unskilled workers. In those days the cost of cheap labor did not compare unfavorably with the machines. But, unforeseen factors have altered the situation. The great increase in wages, limitation of hours of work, and the decreased productivity of workers have brought about a situation where now an immediate mechanization is thought to

be the best solution of the economic problem in steel and iron.

These statements can be illustrated by the cost sheets of one of the major steel manufacturers. The average labor cost per ton of finished steel in 1939 was Rs.31.54 which in 1948 was Rs.92.8 (up three times) whereas the average output per worker went down from 24.36 tons to 16.30 tons (down one third). This means that the cost of production of a ton of steel increased 194% in one decade. This is a very sorry state of affairs, even without considering that the buying power of the rupee has also gone down considerably during the same time.

#### COAL

In comparison with our reserves of iron ore, our metallurgical coal reserves are low. Restricting the estimates to 4-ft. seams and taking the maximum workable depth as 1000 ft., our reserves of all grades of coal have been computed to be 20,000,000,000 tons. Even the estimated 700,000,000 of coking coal contain high ash; if washed, the amount will shrink to 500,000,000.

Even after washing, the ash content may be 15%. If the ash is reduced further, the recovery is very low. Considering the advantages of a low slag fall in the blast furnace, it may be economic to gasify part of the coal and introduce it through supplementary tuyeres. This appears to be a radical method of "cleaning" high-ash coals, but it is not altogether visionary since prewar German researches indicate that only 35% of the blast furnace's fuel is utilized for metallurgical reactions, whereas the remainder preheats the burden. If fuel is charged partly in the gaseous and partly in the solid form, it will obviously require some modification in the present designs of the furnaces.

The coal industry in India produces some 30,000,000 tons of coal per annum, which is enough for internal use and some moderate exports to the neighboring countries. At this rate our reserves are enough to last 700 years.

#### MANGANESE

India is the second largest producer of manganese in the world in tonnage; on a quality basis her manganese is best. Though production varies from 300,000 to 1,000,000 tons per year, the internal consumption does not exceed 80,000 tons. The rest is exported.

Manganese is widely distributed, but from the standpoint of the (Continued on p. 218)

# INTRICATE LARGE CASTINGS ...readily produced in DUCTILE IRON

**DUCTILE IRON** is a cast ferrous product that combines the *process advantages* of cast iron with many of the *product advantages* of cast steel.

In less than two years, ductile iron has attained wide acceptance because it offers excellent castability, high mechanical properties, and good machinability. Parts cast in ductile iron show superior pressure tightness, high modulus and resistance to shock.

Typical current applications include chemical pots, compressor shells, cylinders for hydraulic presses, fly wheels, housing for electric power driven tools, large gears for coal mine equipment, vise jaws, and many other parts.

## AVAILABILITY

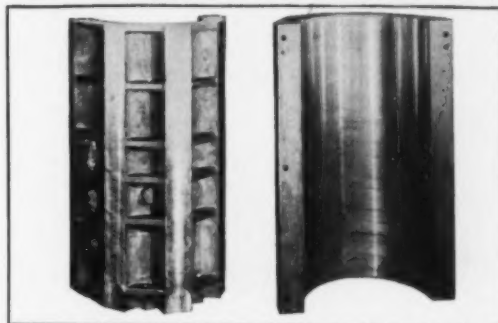
Send us details of your prospective uses, so that we may suggest a source of supply from some 100 authorized foundries now producing ductile iron under patent licenses. Request a list of available publications on ductile iron . . mail the coupon now.



**ST. PAUL FOUNDRY & MANUFACTURING CO.**, St. Paul 3, Minn., cast this hydraulic head for a billet conditioner in ductile iron having 92,000 p.s.i. tensile strength, 67,000 p.s.i. yield point and 7.8% elongation.



**STAVER FOUNDRY COMPANY**, Virginia, Minn., produced this large hoist drum in ductile iron to meet requirements of toughness with strength, and wear resistance with good machinability.



**PYOTT FOUNDRY & MACHINE CO.**, Chicago 7, Ill., produced these ductile iron castings for dies for forming 24" to 36" diameter pipe from steel plate of 1/4" to 1/2" thicknesses. The finished tooling was done by the Vernon Allsteel Press Co. of Chicago. The dies are to be used in large presses that exert 18,000 tons pressure.



The International Nickel Company, Inc.  
Dept. M.P., 67 Wall Street, New York 5, N. Y.

Please send me a list of publications on: **DUCTILE IRON**

Name.....Title.....

Company.....

Address.....

City.....State.....

**THE INTERNATIONAL NICKEL COMPANY, INC.** 67 WALL STREET  
NEW YORK 5, N.Y.

# American Society for Metals

ALBERT E. WHITE	1921
FRANK P. GILLIGAN	1922
†TILLMAN D. LYNCH	1923
†GEORGE K. BURGESS	1924
†WILLIAM S. BIDLE	1925
†ROBERT M. BIRD	1926
J. FLETCHER HARPER	1927
FREDERICK G. HUGHES	1928
ZAY JEFFRIES	1929
†ROBERT G. GUTHRIE	1930
J. MITCHELL WATSON	1931

## PRESIDENTS

ALEXANDER H. J'ARCAMBAL	1932
WILLIAM B. COLEMAN	1933
†WILLIAM H. PHILLIPS	1934
BENJAMIN F. SHEPHERD	1935
ROBERT S. ARCHER	1936
EDGAR C. BAIN	1937
GEORGE B. WATERHOUSE	1938
WILLIAM P. WOODSIDE	1939
JAMES P. GILL	1940

OSCAR E. HARDER	1941
BRADLEY STOUGHTON	1942
HERBERT J. FRENCH	1943
MARCUS A. GROSSMANN	1944
KENT R. VAN HORN	1945
CHARLES H. HERTY, JR.	1946
ALFRED L. BOEGEHOLD	1947
FRANCIS B. FOLEY	1948
HAROLD K. WORK	1949
ARTHUR E. FOCKE	1950
W. E. JOMINY	1951

## SECRETARY

WILLIAM H. EISENMAN	1920-
---------------------	-------

## FOUNDER MEMBERS

†T. E. BARKER	†A. G. HENRY	WM. H. EISENMAN	WM. P. WOODSIDE	A. E. WHITE
---------------	--------------	-----------------	-----------------	-------------

## HONORARY MEMBERS

KOTARO HONDA	CHARLES F. KETTERING	ZAY JEFFRIES	WILLIS R. WHITNEY
AXEL HULTGREN			B. F. FAIRLESS

## SAUVEUR ACHIEVEMENT MEDALISTS

†ALBERT SAUVEUR	1934	†ALBERT L. MARSH	1941	ROBERT S. ARCHER	1945
ZAY JEFFRIES	1935	BENJAMIN F. SHEPHERD	1942	EDGAR C. BAIN	1946
WILLIAM R. CHAPIN	1936	CHARLES H. HERTY, JR.	1943	F. P. ZIMMERLI	1947
HARRY W. McQUAID	1938	WALTER E. JOMINY	1944	M. A. GROSSMANN	1949
†STANLEY P. ROCKWELL	1939			CLARENCE E. SIMS	1950
A. W. MACHLET	1940			R. F. MEHL	1951

## HENRY MARION HOWE MEDALISTS

E. J. JANITZKY	1922	CYRIL WELLS	1932	GERHARD ANSEL	1939	S. G. FLETCHER	1945
FRANCIS F. LUCAS	1924	MAXWELL GENSAMER	1932	ROBERT F. MEHL	1939	MORRIS COHEN	1945
WESLEY P. SYKES	1925	JOHN F. ECKEL	1932	M. A. GROSSMANN	1941	CHARLES R. AUSTIN	1946
OSCAR E. HARDER	1928	JOSEPH V. EMMONS	1933	MORRIS ASIMOW	1941	MAURICE C. FETZER	1946
RALPH L. DOWDELL	1928	JOHN CHIPMAN	1934	S. F. URBAN	1941	W. A. PENNINGTON	1947
H. J. FRENCH	1930	NICHOLAS A. ZIEGLER	1935	W. A. SCHLEGEL	1942	J. W. SPRETNAK	1948
EDGAR C. BAIN	1931	A. G. H. ANDERSEN	1937	SHADBURN MARSHALL	1943	B. L. AVERBACH	1949
KARL HEINDLHOFFER	1931	ERIC R. JETTE	1937	B. A. FLINN	1944	W. O. BINDER	1950
FRANCIS M. WALTERS	1932	JOSEPH WINLOCK	1938	EARNSHAW COOK	1944	C. M. BROWN	1950
		R. W. E. LEITER	1938	J. A. FELLOWS	1944	RUSSELL FRANKS	1950
		C. S. BARRETT	1939	DARA P. ANTIA	1945	B. J. LAZAN	1951

## THE GOLD MEDAL OF THE AMERICAN SOCIETY FOR METALS

ZAY JEFFRIES	1943	EARLE C. SMITH	1945	C. H. MATHEWSON	1947	F. C. FRARY	1948	EDGAR C. BAIN	1949
		PAUL D. MERICA	1951						

## THE A.S.M. MEDAL FOR THE ADVANCEMENT OF RESEARCH

ROY A. HUNT	1943	GERARD SWOPE	1945	C. R. HOOK	1947	FRED H. HAGGERSON	1949
†ROBERT C. STANLEY	1944	R. E. ZIMMERMAN	1946	†W. H. DOW	1948	CHARLES E. WILSON	1950
		GWILYM A. PRICE	1951				

## CHAIRMAN OF PUBLICATIONS COMMITTEE

WILLIAM B. COLEMAN	1929-30	A. ALLAN BATES	1936-38	WALTER CRAFTS	1947
VICTOR O. HOMERBERG	1930-32	M. GENSAMER	1941-43	A. O. SCHAEFER	1948
AUGUSTUS B. KINZEL	1932-33	E. G. MAHIN	1944	R. H. ABORN	1949
GERALD R. BROPHY	1933-34	CLAIR UPTEGROVE	1945	A. R. TROIANO	1950
WESLEY P. SYKES	1934-36	R. M. BRICK	1946	W. A. PENNINGTON	1951

## CHAIRMAN OF METALS HANDBOOK AND PREDECESSOR COMMITTEES

J. FLETCHER HARPER	1923-27	JAMES P. GILL	1936-37	ROBERT S. ARCHER	1939-42
L. B. CASE	1931-33	RALPH L. DOWDELL	1937-39	G. V. LUERSSSEN	1942-46
CHARLES H. HERTY, JR.	1933-36			J. B. JOHNSON	1947-

## CAMPBELL MEMORIAL LECTURERS

WILLIAM M. GUERTLER	1926	JAMES P. GILL	1936	GEORGE R. FITTERER	1944
ZAY JEFFRIES	1927	WESLEY P. SYKES	1937	MAXWELL GENSAMER	1945
MARCUS A. GROSSMANN	1930	ALFRED L. BOEGEHOLD	1938	JAMES B. AUSTIN	1946
CHARLES H. HERTY, JR.	1931	EDMUND S. DAVENPORT	1939	A. B. KINZEL	1947
EDGAR C. BAIN	1932	SAMUEL L. HOYT	1940	MORRIS COHEN	1948
HERBERT J. FRENCH	1933	ROBERT F. MEHL	1941	EDGAR H. DIX, JR.	1949
VSEVOLOD N. KRIVOBOK	1934	JOHN CHIPMAN	1942	EARLE C. SMITH	1950
HARRY W. McQUAID	1935	C. R. MATHEWSON	1943	C. H. LORIG	1951

†Deceased

# HOW CLAYTON MFG. CO. GETS CLEAN BRIGHT BLADES



by using AEROCARB® E&W Carburizing Compounds



— Submerged to a point just above the shoulder,  $3\frac{1}{2}$ " to 8" scissors and shear blades of SAE 1020 steel are carburized in an AEROCARB E&W bath at 1600°F, to a case depth of at least .020", depending upon the amount of finish grinding needed. Blades are oil quenched at about 125°F, hot water rinsed, and tempered for 20 minutes in a salt bath at 600°F.

In a second application, AEROCARB E&W acts as a heating medium for  $3\frac{1}{2}$ " to 9" high carbon scissors and shears. These are heated to 1525°F, immediately oil quenched, hot water rinsed and then tempered in a salt bath at about 700°F.



Final Rockwell C hardness is between 52 and 55.

Advantages! AEROCARB E&W is a water soluble salt which can be removed quickly and completely by a brief warm water wash, leaving parts with a clean, bright finish. Also, this two-way use of AEROCARB E&W—as a carburizing bath and as a heating medium—simplifies Clayton's inventory.

Let Cyanamid technical service and heat treating compounds team up to help you meet rigid specifications required on defense and civilian contracts...

Next time, call Cyanamid first.

SEE AEROCARB E&W IN ACTION  
AT THE  
METAL SHOW BOOTH G-452  
DETROIT • OCT. 15th, 1951

Cyanamid's heat treating compounds include:

AEROCARB® Carburizing Compounds  
AEROCASE® Case Hardening Compounds  
AEROHEAT® Heat Treating Compounds



AMERICAN Cyanamid COMPANY

MP 10

INDUSTRIAL CHEMICALS DIVISION  
30 Rockefeller Plaza, New York 20, New York

- ☐ Send technical data sheet on AEROCARB E&W.
- ☐ Have technical service representative call.

Name \_\_\_\_\_ Position \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_

District Offices: Boston • Philadelphia • Baltimore • Charlotte • Cleveland • Chicago  
Kalamazoo • St. Louis • Los Angeles  
In Canada: North American Cyanamid Limited, Toronto and Montreal



# HIGHEST RESOLUTION for Every Magnification

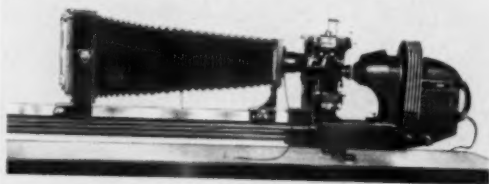
## *Plus-* WIDEST SELECTION of Resolving Powers

Photographic Mag.	OBJECTIVES						EYEPICES			Approx. Bellows Draw, in.
	Achromatic		Fluorite		Apochromatic		Hypg.	Hyper.	Amp.	
	Mag.	N.A.	Mag.	N.A.	Mag.	N.A.				
25x	6.5x	0.10					5.0x			7.7
50x	6.5x	0.10					5.0x			15.4
75x	6.5x	0.10					6.4x			18.0
	8.0x	0.20					6.4x			14.6
	13.0x	0.25					5.0x			11.5
100x	8.0x	0.20					6.4x			19.5
	13.0x	0.25					5.0x			15.4
150x	13.0x	0.25					6.4x			18.0
200x	20.0x	0.40						10x		10.0
250x	20.0x	0.40						10x		12.5
500x	37.0x	0.65							10x	10.8
750x			55x	0.85					10x	11.0
					60x	0.95			10x	9.8
1000x			53x	1.00					10x	16.2
					60x	0.95			10x	14.0
1500x			85x	1.25					10x	15.0
					77x	1.40			10x	16.8
2000x					77x	1.40			10x	23.3

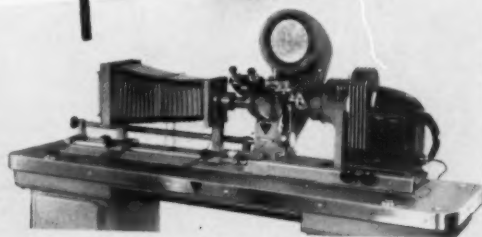
ASTM STANDARD MAGNIFICATIONS AND RECOMMENDED  
OPTICAL COMBINATIONS FOR PHOTOMICROGRAPHY

## COMPARE the Exclusive Flexibility of Bausch & Lomb METALLOGRAPHS!

The variety of numerical apertures offered with Bausch & Lomb Metallographs gives you two important advantages . . . highest resolution for every magnification . . . plus a wide selection of resolving powers where specifically required. Resolution is controlled at will and not fixed for the average. Clearer, sharper, better defined visual and photomicrographic images are the result. These exclusive features make B&L Metallographs the world's finest for research and quality control—by performance proof.



B&L RESEARCH METALLOGRAPH Catalog E-240



B&L BALPHOT METALLOGRAPH Catalog E-232



B&L PHOTOMICROGRAPHIC  
EQUIPMENT MODEL L  
Catalog E-210



B&L CM METALLURGICAL  
MICROSCOPE  
Catalog E-223



B&L STEREOSCOPIC  
WIDE FIELD MICROSCOPES  
Catalog D-15

COMPARE, too, the **EXCLUSIVE** Adaptability of the **COMPLETE** Bausch & Lomb Line . . .

In addition to B&L Metallographs there's a complete line of B&L precision instruments to help you save materials and manpower in all phases of metallurgical research and production.

WRITE for complete information to Bausch & Lomb Optical Co., 638-10 St. Paul St., Rochester 2, N. Y.

SEE THEM AT THE NATIONAL METAL EXPOSITION, DETROIT, OCT. 15-19, SPACE B-102



# Bausch & Lomb Metallurgical Equipment

# Improved Aluminum Bearings (Al-Sn and Al-Sn-Cu Alloys)

**A**LUMINUM-TIN ALLOYS offer a promising field for the development of new bearing materials. According to Hunsicker and Kempf<sup>1</sup> the scuffing load on a certain bearing lined with pure aluminum is as low as 50 lb., whereas this increases continuously with the addition of tin to the alloy, reaching about 450 lb. at 25% tin. Commercial aluminum bearings normally contain 6 to 7% of tin together with minor constituents such as copper, nickel, and silicon, and are generally used in the cast and stabilized condition. They possess a low coefficient of friction at high bearing loads and a good resistance to seizing.

In previous work it developed that properties at room temperature and at the moderately elevated temperatures (reached by the bearings during operation) are pronouncedly affected by the microstructure. For example, fatigue limit at 70° F. is reduced by quantities of tin sufficiently great to form a continuous phase through the matrix. Furthermore, reduced ductility at elevated temperature is associated with a particular tin distribution—continuous interdendritic and intergranular films.<sup>1</sup> (References will be found on p. 224.)

Improved mechanical properties both at room and elevated temperatures are associated with discrete particles of tin in a continuous aluminum matrix. This can be achieved by control of casting conditions, or more readily by cold working followed by recrystallization. Alloys containing 30% tin or more with excellent mechanical properties can be produced by the latter method and may combine the softness of babbitt with many times its fatigue resistance at operating temperatures (around 300° F.) and their major constituent is aluminum. As to strategic alloys, the present supply of both constituents is good.

Our experiments were made on laboratory

melts cast into DTD standard  $\frac{1}{2}$ -in. round test bars, 6 in. long. Molds were either baked sand, aluminum bronze, or "water chill cast" (by pouring into a  $1\frac{1}{4}$ -in. cylindrical thin sheet steel container and allowing water to rise in an outer container at such a rate that directional solidification occurred from the bottom of the ingot). These various molds enabled us to study the influence of rate of solidification on microstructure.

**Tin Distribution**—The following account has been extracted directly from Hunsicker's paper:<sup>3</sup>

"The size, shape and distribution of the tin constituent in binary aluminum-tin alloy castings vary primarily with the tin concentration and the solidification rate, although minor microstructural changes may be effected by heating the alloys to temperatures above the eutectic temperature. With increasing concentrations of tin it tends to form interdendritic and intergranular networks of increasing continuity. This tendency, within certain concentration ranges, can be counteracted by increasing the rates of solidification, as well as by the addition of certain other alloying elements (notably silicon). At tin concentrations in excess of about 20%, the tin is the continuous constituent, even with the most rapid practical rates of solidification."

In our work, a very large number of photomicrographs were made. Rather than reproduce them all, which would consume inordinate space, a code was adopted to represent distribution of tin particles, and the structures are described in a series of tables. (A few representative micros will also be shown.) The code used in these tables is given overleaf. In the

**By H. K. Hardy, E. A. G. Liddiard**  
Fulmer Research Institute

**J. Y. Higgs and J. W. Cuthbertson**  
Tin Research Institute  
England

Mr. Hardy is head of physical metallurgy section and Mr. Liddiard is director of research for Fulmer Research Institute, Stoke Poges, Buckinghamshire, England. Mr. Higgs is research metallurgist and Mr. Cuthbertson is assistant director of research for Tin Research Institute, Greenford, Middlesex, England.

**Table I—Distribution of Tin Particles in Binary Al-Sn Alloys With Different Rates of Solidification**

CASTING METHOD	TIN CONTENT, %							
	5	7.5	10	12.5	15	20	25	30
Sand	F	—	F	—	F	F	—	F
Chill	DF/G†	—	DF/G	—	F*	F	—	F
Water								
chill	F/e	F/e	F/e	F/e	F/e‡	F/e	F/e	F/e

\*Fig. 1. †Fig. 2. ‡Fig. 3.

**Code Used in Tables**

- F Continuous interdendritic films
- DF Discontinuous interdendritic films
- G Discrete globules
- P Discrete particles other than globules
- e Fine eutectic with discontinuous films
- c Structure is large and coarse
- Alloy not made
- () Parentheses represent small amount of phase
- Structure in process of change

event the structure is mixed, containing more than one of the above, two symbols are separated by an inclined line.

Binary aluminum-tin alloys are described in Table I. All sand cast bars and chill cast bars with 15% tin or more showed continuous interdendritic films of tin (see Fig. 1). All alloys cast in water chills had continuous interdendritic films, plus regions (varying in proportion) which were much finer in scale and probably corresponded to eutectic colonies, as shown in Fig. 3.

Effect of copper was studied by adding it progressively to an 85% Al, 15% Sn base. Microstructures are summarized in Table II. Discon-

tinuous films appeared in sand cast bars with 3.0% and more copper, and in chill cast bars with 1.0% and more copper. The alloys cast in water chills showed continuous films but the continuity of the fine eutectic structure was broken with more than 1.5% of copper, as typified in Fig. 4.

Similarly, effect of variable tin was studied in a base alloy of 97% Al, 3% Cu (see Table III), and in a base alloy of 98% Al, 2% Cu (see Table IV). Continuous films were absent in all sand cast alloys, in all chill cast except the one with 30% tin. The water chill cast alloys possessed continuous films of tin but the fine eutectic structure was normally discontinuous (Fig. 4).

**MELTING CONDITIONS**

Varied melting conditions made no observable effect on the resulting structure. This statement applies to bars cast at 1310 to 1380° F. (710 to 750° C.), degassed with chlorine, degassed with flux, or cast without degassing.

The results described above are in substantial agreement with the conclusions given by Hunsicker except that there is a reversal to the film type of distribution in the water chill cast specimens. The rate of solidification applying in this instance may have been greater.

It is evident from these tests that a discontinuous distribution of tin particles can be obtained in binary alloys with up to at least 10% of tin by using a suitable rate of solidification. This range can be extended to 20% tin by the addition of 2 to 3% of copper.

Representative Microstructures, As Cast; 100×; Etched in 2½% Ammonium Persulphate Solution Which Blackens Tin

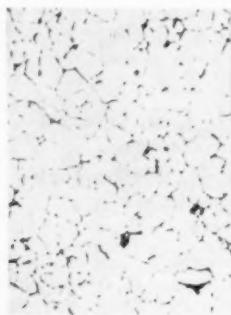


Fig. 1—Chill Cast; 85% Al, 15% Sn; Continuous Films. Sand cast grains are very much larger

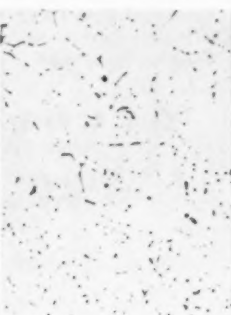


Fig. 2—Chill Cast; 95% Al, 5% Sn, Discontinuous Films and Globules

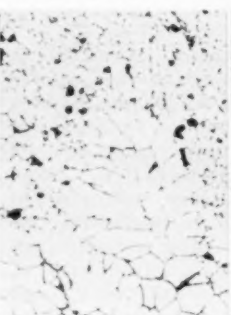


Fig. 3—Water Chill Cast; 85% Al, 15% Sn; Continuous Films and Eutectic

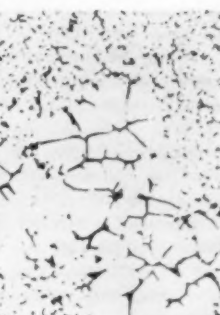


Fig. 4—Water Chill Cast; 82% Al, 15% Sn, 3% Cu; Continuous Films and Discontinuous Eutectic

Table II—Distribution of Tin Particles in Ternary Al-Cu-15% Sn Alloys With Different Rates of Solidification

CASTING METHOD	COPPER CONTENT, %								
	NIL	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Sand Chill	F	F	F	F	F	—	DF	—	DF/G
Water chill	F*	F	DF/G	G	G	DF/G	G	DF/G	DF/G
	F/e†	F/e	F/e	F/de	F/de	—	F/de‡	—	DF/de

\*Fig. 1. †Fig. 3. ‡Fig. 4.

#### TIN DISTRIBUTION IN WROUGHT ALLOYS

Notwithstanding the last statement, it is quite possible that a commercially and technically desirable alloy and casting conditions may produce metal with undesirable films of tin in its structure. We therefore inquired into the possibility of breaking up these films by heat treatment, cold work, or a combination of both, choosing the water chill cast specimen of the 70-30 Al-Sn alloy. Its structure is essentially like the one shown in Fig. 3.

As-cast samples, annealed various times from ¼ to 48 hr. at temperatures from 430 to 930° F. (220 to 500° C.), gave a mixture of globular particles and films. Heat treatment at the higher temperatures produced a coarse structure in a shorter time, but grain boundary films were always present.

Samples stretched 5 to 30% and then annealed at 430° F. (220° C.) changed very little in micro-

structure, although the fine eutectic may have balled up slightly, as in Fig. 6.

Similarly, stretching 5 or 10% did not have a very pronounced influence on the microstructural changes during the subsequent heat treatment at a higher temperature than 430° F. The transfer from the

Table III—Distribution of Tin Particles in Ternary Al-3% Cu-Sn Alloys With Different Rates of Solidification

CASTING METHOD	TIN CONTENT, %						
	5	10	12.5	15	17.5	20	30
Sand	—	DF	—	DF	—	DF	—
Chill	G	DF/G	DF/G	G	DF/G	DF	F
Water	—	F/de	—	F/de*	—	F/de	F/de
chill							

\*Fig. 4.

Table IV—Distribution of Tin Particles in Ternary Al-2% Cu-Sn Alloys With Different Rates of Solidification

CASTING METHOD	TIN CONTENT, %		
	15	20	30
Sand Chill	DF	DF	F
Water chill	G	G	DF/G
	F/de	F/e	F/e

cast structure to the mixture of globules and films occurred over much the same temperature range, but the microstructures contained films after all heat treatments.

Stretching 20 and 30% and then annealing was more successful, as shown in Table V.

Cold working 20 and 30% greatly reduced the tendency to retain films on annealing at 660° F. (see Fig. 7 and 8), but there was a tendency to revert to films at the higher annealing temperatures.

It thus appears that discontinuous particles

#### Representative Microstructures of Cold Worked and Heat Treated 70-30 Al-Sn Alloys; 150×

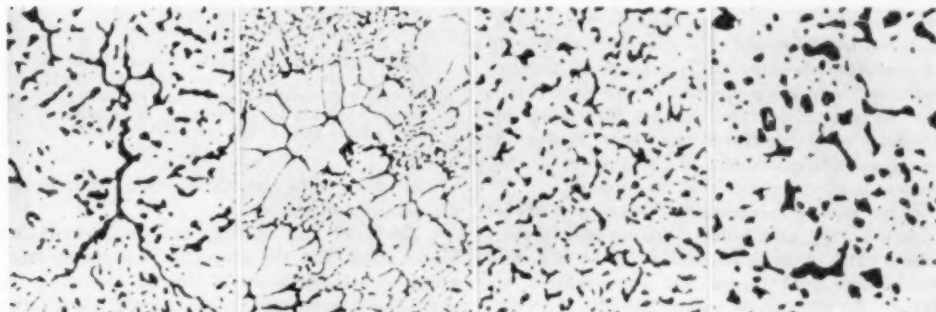


Fig. 5—Stretched 10%, Annealed 4 Hr. at 570° F.

Fig. 6—Stretched 20%, Annealed 48 Hr. at 430° F.

Fig. 7—Stretched 20%, Annealed 1 Hr. at 660° F.

Fig. 8—Stretched 20%, Annealed 16 Hr. at 660° F.

Table V — Microstructure of 70-30 Al-Sn Alloys After Cold Work and Heat Treatment

STRETCH	HEAT TREATMENT, TIME AND °F.						
	HOURS	480°	570°	660°	750°	840°	930°
20%	¼				F → G	G/F	P/G → F
	1	F/c	F → G	G/P(F) *	P/(F)	P/F	P → F
	4	F → G	G/F	G/P/(F)	P/(F)	P → F	P → F
	16	G/F	G/F	cP†			
	48						
30%	¼				P(F)	G	cP → F
	1	F → G	F → G	P	P/G	P	cP/G → F
	4	F → G	P/G	P	cP	cP → F	cP/G → F
	16	G	P/G	cP	P		cP/G → F
	48						

\*Fig. 7. †Fig. 8.

are favored by a high degree of cold work and recrystallization at low temperature. Stretching by 20% is probably the minimum degree of cold work, and 660° F. (350° C.) the optimum annealing temperature for such desirable results. Higher temperatures may be used but the degree of cold work must then be increased. A completely discontinuous structure was not obtained by annealing the unworked alloys, although the intragranular distribution of the excess constituent was radically altered.

Recrystallization is necessary to transform the intergranular films into discrete particles. The shape and size of the molten tin particles are determined by the relative interfacial energies and movement of the aluminum crystals during recrystallization and grain growth. Tin particles totally enclosed within grains tend to be globular.

#### HIGH-TEMPERATURE TENSILE TESTS

It has been shown above that unfavorable tin distribution can be transformed to discrete particles by cold working and recrystallization. When the tin is in the form of continuous films the ductility of the alloys falls as the testing temperature is raised.<sup>4</sup> The contrary effect is to be expected when the tin is present as discrete particles, since the properties of the matrix will then be more important. In fact, the change of ductility with temperature has been used as a semiquantitative measure of the success of the process in alloys of different tin contents.

Our high-temperature tests were performed on water chill cast billets with an aluminum: copper ratio of 98:2, containing up to 60% Sn, which were cold forged and recrystallized at 660° F. (350° C.) and air cooled. Results of tensile tests at 20, 100 and 200° C. are given in Fig. 9. Figures for elongation, placed at respective points

in this diagram, show improved ductility with increasing test temperatures in alloys containing up to 40% tin. Exactly analogous results were obtained when the copper was replaced by 2.5% of silicon.

#### WROUGHT AL-SN-CU ALLOYS

Aluminum-tin alloys containing copper are susceptible to heat treatment. Results of tensile tests at room temperature on such

alloys are shown in Table VI. The samples were cold worked but were otherwise treated normally. No quench cracking occurred. Tin sweat appeared but was limited to the surface

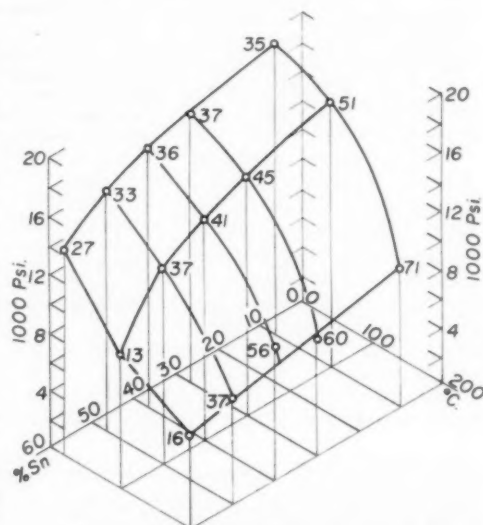


Fig. 9 — High-Temperature Tensile Tests on Ternary Alloys Based on 98-2 Al-Cu Ratio. Figures represent elongations. Test bars cold forged from 2¼ in. diameter to ¾ in. square, and annealed 1 hr. at 660° F. (350° C.)

layers; it would be immaterial when followed by a machining operation.

Table VI and similar tests on 96-4 Al-Cu alloys show that the properties when annealed are almost independent of the tin content. (It should be remembered that very small quantities of tin, of the order of 0.05%, markedly increased the properties after artificial aging.<sup>4, 8</sup>)



Representative microstructures are illustrated by Fig. 10 to 13. The forged alloy showed elongated dendrites and continuous films, Fig. 10. After recrystallization at 660° F. (350° C.) the tin phase was present as small angular particles, Fig. 11.

A more equiaxed distribution was achieved in the alloys annealed at 930° F. (500° C.). Alloys containing 40% of tin then possessed a semi-continuous network, as shown in Fig. 12, but the network was more or less complete when 50% tin was present.

The molten tin particles move during heat treatment in accordance with the requirement of minimum interfacial energy—mechanically, also, as they are displaced by the recrystallizing aluminum solid solution. The insoluble constituents tend to be absorbed by the tin during this process, leading to the microstructure shown in Fig. 13.

#### TIN DISTRIBUTION DOMINATES PROPERTIES

Analysis of our test results and corresponding microstructures provide a very strong confirmation of the dominant influence of the tin distribution. Discrete tin particles are associated with good values of ductility. Even after high-

Table VI—Tests on Cold Worked and Heat Treated Alloys Based on 97-3 Al-Cu Ratio

PROPERTY	TIN CONTENT			
	NONE	10%	20%	30%
Annealed 1 Hr. at 660° F. (350° C.)				
0.1% proof stress	6,000	6,700	6,300	6,700
Ultimate stress	22,200	22,000	21,500	23,700
Elongation	36%	33%	33%	29%
1 Hr. at 930° F. (500° C.), Water Quenched, Aged 16 Hr. at 330° F. (165° C.)				
0.1% proof stress	25,500	20,600	22,600	18,400
Ultimate stress	38,500	32,000	32,900	27,800
Elongation	20%	16%	11%	16%
1 Hr. at 930° F., Water Quenched, Aged 14 Days at 70° F.				
0.1% proof stress	7,400	7,800	8,900	6,700
Ultimate stress	29,100	26,000	26,000	23,700
Elongation	35%	31%	24%	29%

temperature annealing of alloys with high-tin content (which results in large tin particles) the elongations are above 20%. However, films are harmful to this property.

The ability of the alloys to withstand quenching without cracking makes it possible to provide a range of properties for alloys with a wide variation in tin content. For example, an alloy with 45% tin gave a maximum stress value of 27,000 psi. and 18,000 psi. for the 0.1% proof stress. In the 30% tin alloy the hardness may vary from 20 Vickers for the pure binary to 80 for the fully heat treated 3% copper ternary alloy. Within reason, the tensile properties required may be obtained by a suitable choice of alloy composition and heat treatment.

The tendency of the elongation values to fall with increasing tin content probably sets the

Microstructure of Forged and Heat Treated Al-Sn-Cu Alloys. 150× except Fig. 13, which is 600×



Fig. 10—1.6% Cu, 20% Sn, Cold Worked From 2 1/4 In. Dia. to 1/4 In. Square; Not Annealed

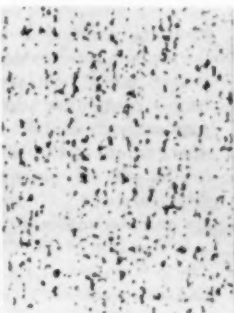


Fig. 11—Same as Fig. 10, Annealed 1 Hr. at 660° F.

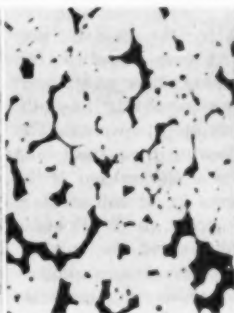


Fig. 12—1.2% Cu, 40% Sn, Cold Flattened From 2 1/4 to 1/4 In. Annealed 1 hr. at 930° F.



Fig. 13—2.1% Cu, 30% Sn, Treated as Fig. 12 600×, Etched in 0.5% HF

upper limit at 30% for alloys undergoing full heat treatment. Excessive bleeding of the cast billets during annealing prior to cold working occurs when the tin exceeds 40%, but it is of interest to record that forgings have been made containing 60% of tin.

#### FATIGUE STRENGTH OF SELECTED ALLOYS

Alternating bending tests were made with machines of the rotating load type wherein the specimen is stationary; its temperature can therefore be more accurately maintained and measured. The machines themselves were built

1% Ni, balance Al, known in Great Britain as AC9 and in the United States as Alcoa 750.

In the cast condition this alloy had Vickers hardness of 69.6. Its fatigue strength (from S-N curves which flattened out at about  $50 \times 10^6$  cycles of stress) was 8800 psi. at room temperature and 9000 psi. at 300° F. (150° C.). In a similar alloy in the slightly cold worked condition the hardness was 55.9, and fatigue strength was 8900 psi. at 70°, and 7400 psi. at 300° F.

For a bearing material these fatigue values are encouragingly high but they are unfortunately coupled with high hardness—about three times that of tin-base babbit. Room temperature hardness of a bearing alloy intended to run on an unhardened journal should not be greater than 30 on the Vickers scale. The obvious way of softening these aluminum-base alloys is to reduce their content of hardening constituents and possibly to increase their tin content, if this could be done without at the same time reducing the fatigue strength to a point where the alloys would have nothing to offer in this respect over existing soft bearing materials.

A comprehensive program of fatigue testing on high-tin alloys was therefore arranged. The work at 20 and 150° C. on the binary aluminum-tin and ternary aluminum-tin-copper alloys, all containing 30% tin, is now complete. All tests were done on material that had

Table VII—Fatigue Tests on Aluminum-Base Alloys Containing 30% of Tin

COMPOSITION OF ALLOY	TREATMENT	TESTING TEMPERATURE		FATIGUE STRENGTH, PSI.	VICKERS HARDNESS
		°F.	°C.		
70% Al 30% Sn	Cold worked; annealed 1 hr. at 660° F.	70 300	20 150	$\pm 3500$ $\pm 3000$	22
69% Al 30% Sn 1% Cu	Cold worked; heat treated 1 hr. at 930° F.; quenched; aged for 16 hr. at 330° F.	70 300	20 150	$\pm 6500$ $\pm 4600^*$	27
67% Al 30% Sn 3% Cu	Cold worked; annealed 1 hr. at 660° F.	70 300	20 150	$\pm 7100$ $\pm 4600$	37
67% Al 30% Sn 3% Cu	Cold worked; heat treated 1 hr. at 930° F.; quenched; aged for 16 hr. at 330° F.	70 300	20 150	$\pm 9800$ $\pm 5400^\dagger$	80

\*S-N curve not horizontal; endurance limit estimated at  $\pm 4400$  psi.

†For  $10^8$  reversals; alloy probably changing by overaging during test.

to the design developed by the British Non-Ferrous Metals Research Assoc., and a full description of them has already been published.<sup>9</sup>

The machines may be regarded as the counterpart of the Wohler machine in reverse. The stress variation in the two is the same, each point on the circumference of the test bar at the position of maximum stress being subjected to a sinusoidal variation of stress, the cycle being completed for each revolution of the spinner. The speed of operation is 3000 r.p.m.—comparatively slow—and this explains why the tests described were discontinued at  $10^8$  revolutions.

To obtain a standard for comparison, tests were carried out on two commercial bearing alloys containing approximately 6% Sn, 1% Cu,

been cold worked and heat treated to break up the primary intercrystalline network. In addition, the effect of heat treating the matrix of the copper-containing alloys was examined. Microscopical examination showed a fairly uniform distribution of the tin and not much variation in the size of the individual particles. Tests were carried to  $10^8$  reversals of stress. Results are summarized in Table VII.

Two important observations were made: (a) The S-N curves at room temperature in general had flattened out at around  $50 \times 10^6$  reversals, whereas the curves for high temperature were still falling at  $10^8$  reversals; (b) the tendency for the high-temperature curves to flatten out at  $10^8$  reversals was much less pronounced for the

copper-containing alloys, fully heat treated, than for the remaining materials. Thus, the test values at 20° C. in Table VII may be accepted as truly representing the fatigue properties of the materials at that temperature, but the values recorded at 150° C. are all too high — yet only significantly so for the fully heat treated ternary alloys.

This effect is almost certainly connected with the well-known aging characteristics of magnesium-free aluminum-copper alloys containing tin. Overaging (with consequent loss of tensile strength) is likely to occur after some days at 300° F. (150° C.).

#### COMPARISON WITH BABBITT

The fatigue strength of a typical tin-base babbitt may be taken as about  $\pm 4000$  psi. at room temperature and  $\pm 2200$  psi. at 100° C.; the room-temperature hardness is around V.P.N.24. Its fatigue strength at 300° F. (150° C.) is unknown, but (bearing in mind its low melting point and remembering that its tensile strength diminishes by one third and the modulus of elasticity by one half on heating from 100 to 150° C.) it would certainly be safe to assume that the fatigue strength of babbitt at 150° C. would be well below  $\pm 2200$  psi. The lowest result in Table VII — namely  $\pm 3000$  psi. for the 30% tin binary alloy — represents a very substantial improvement in hot fatigue strength (at working temperatures) as compared with that of babbitt — at least double. When it is borne in mind that this alloy is no harder than babbitt, its endurance is all the more encouraging.

Addition of copper increases the fatigue strength and hardness. With 3% copper the matrix of the Al-Sn alloy can be age hardened in the same way as alloys of the duralumin type; fully heat treated it may be V.P.N.80 hard.

Addition of 1% copper to the 30% tin alloy raises the fatigue limit by two thirds, and only slightly increases the hardness, even after full heat treatment. As already explained, this is one instance where 10<sup>6</sup> reversals of stress are not sufficient to establish the true endurance limit at 150° C., and in practice the alloy would not be expected to withstand indefinitely a stress quite as high as  $\pm 4600$  psi., the value recorded in Table VII. By extrapolation of the curve the fatigue limit at 300° F. (150° C.) is believed to be just below  $\pm 4400$  psi.

With 3% copper the test results depend markedly on the matrix of the alloy. Recorded fatigue values for a soft matrix are little different from those for the heat treated 1% copper alloy, while there is the disadvantage that hard-

ness has been increased to V.P.N.37. A full heat treatment increases the room-temperature fatigue strength about 25%. On a basis of 10<sup>6</sup> cycles, however, it is estimated that the fatigue strength at 150° C. would be nearer  $\pm 4900$ , rather than  $\pm 5400$  psi., reported in Table VII. Also, the form of the fatigue curve suggests that it will still be falling at 10<sup>6</sup> reversals, indicating that the material is actually overaging while the test is proceeding. When its high hardness is considered, this alloy is clearly unattractive as a bearing.

#### GENERAL DISCUSSION

The importance of controlling the tin distribution has been amply confirmed by our studies. Tin has previously been limited in commercial alloys to 6 or 7%, but it could be considerably more in cast alloys without harming mechanical properties at the working temperature. Close control of the casting conditions would be needed, and this might limit castings of high tin content (15%) to simple shapes. Certainly, the practical upper limit in cast alloys is twice the tin content now used commercially.

Cold working and recrystallization provides discrete particles in alloys with five times the tin content of present commercial bearings based on aluminum. A good distribution of tin particles is readily obtained with 30% Sn. The tin particles are finer the greater the degree of cold work and the lower the recrystallization temperature. Alloys containing copper are age hardenable and could be used for massive bearings, although the optimum composition still has to be worked out. Binary aluminum-tin alloys are suitable for use as backed bearings and are being investigated for this purpose.

Alloys containing 30% tin, with or without 1% copper, offer a combination of fatigue strength and softness hitherto unknown in bearing materials. Such soft materials would best be used as a lining, bonded to stronger backing; some progress has been made in bonding techniques. Alloys containing more copper are less attractive, owing to their greater hardness.

The good antifriction properties of tin in a cheap matrix such as aluminum promise new bearing materials with improved properties. This prediction is made on the basis of a desirable combination of hardness, strength, and fatigue resistance, and not on tests of bearings in service. It would therefore be most unwise at this stage to jump to conclusions. Bearing tests, using machines of the Underwood type, are just being started, and judgment must be reserved.

# Deep Welding— a New Method of Oxy-Acetylene Welding

**T**HE LEAST METAL NECESSARY for a weldment is that amount required for a joint having non-beveled, relatively close edges. While such a gap should be the most economical, it is difficult to fuse the bottom edges (the root). This difficulty can be overcome by adjusting and applying the oxy-acetylene flame in such a manner that its action is most effective at these root edges. To insure such efficiency, the edges should be near the source of heat — specifically, close to the cone of the flame and, in particular, the actual *tip* of the cone, where the heat is most concentrated — and further, the largest possible volume of hot gases should reach the root edges at the bottom of the joint.

A new process of "deep welding" has been developed by the author to accomplish the above objectives. It increases welding speed by 50% and lowers the consumption of welding rod and gases. It introduces the flame deep into the gap, which is a butt joint, at right angles to its length, as seen in Fig. 1. By this means the cone of the flame (and in particular its tip) is brought close to the root edges. The tip should reach down at least half the thickness of the plate. Since the flame is moved at right angles to the joint, more hot gases are forced to the bottom edges

than if the flame were inclined at an angle. Deep welding requires a concentrated flame (narrow and pointed) to fit into narrow gaps. It also requires a "harder" flame than that used in other welding methods — that is, a flame with a higher pressure.

To sum up, then, the method calls for a deep, hard and concentrated flame, directed at right angles to the length of the joint, and also

requires a butt joint — plates with nonbeveled edges. These features reduce the material that must be fused, but increase the capacity of the flame to fuse both this material and the requisite part of the abutting edges.

The welding rod must be brought close to the cone of the flame and thus deep into the joint, and moved with well-defined circular or oval movement in the melted material, gradually moving forward. This puddling is to

insure an evenly filled weld and to prevent the formation of gas bubbles in the fused material.

The size of the tip (welding flame) must be adequate to furnish sufficient molten material for a well-fused and filled weld.

The most obvious advantage of deep welding is speed combined with a smaller cost of gas and welding rods. It is clear that when the flame is localized deep down in a narrow gap with straight sides, surface absorption of heat from the flame, both by conduction and by radiation, must be good.

To illustrate the efficacy of the method a number of plates of various thicknesses were deep welded. The amount of gas and rod consumed, gap width and time taken in the welding

**By R. Gunnert**  
Welding Research Laboratory  
Svenska Aktiebolaget  
Gasaccumulator (A.G.A.)  
Stockholm, Sweden

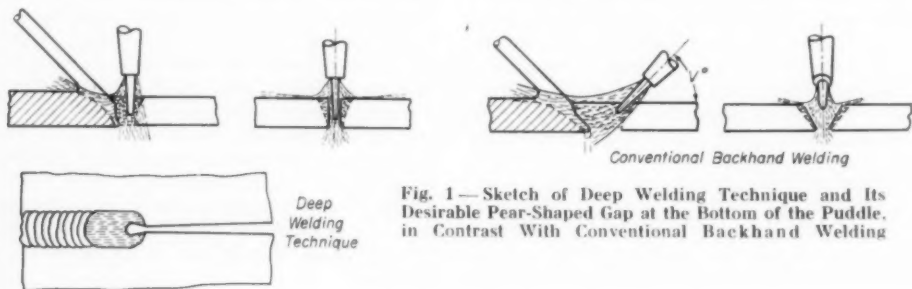


Fig. 1—Sketch of Deep Welding Technique and Its Desirable Pear-Shaped Gap at the Bottom of the Puddle, in Contrast With Conventional Backhand Welding

Fig. 3—Operator Using Depth-Setter and Weld-Rod Holder in Deep Welding a Circular Seam. Note vertical direction of welding blowpipe

were carefully noted. The test welds were made on soft S137 steel (tensile strength 37 kg. per sq.mm. minimum or 52,500 psi.). Pieces 15 to 20 in. wide, 20 in. long, were welded, the weld being 20 in. long. The large width of plate was selected in order that the heat absorption should not be less than in normal production. Actual time taken for the welding is reckoned from the moment when molten material commences to fill up the gap until the flame and rod are finally removed. Replacements of rod are thus included in the time. There were no other interruptions of any importance. A rod-holder was used during the operation (see Fig. 3).

The curves in Fig. 2 compare the results. Backhand welds in  $\frac{1}{8}$  in. and thicker were beveled to 30°, making a V of 60°. Width of gap was 0.4 times plate thickness. These values, as well as the rod sizes, were in accord with standard specifications. The flame was neutral in all cases. All welding was done manually and was of the highest workmanship, being well filled out and properly fused throughout. Three sample welds were made on each plate thickness, and mean values of these three tests are plotted in the diagram.

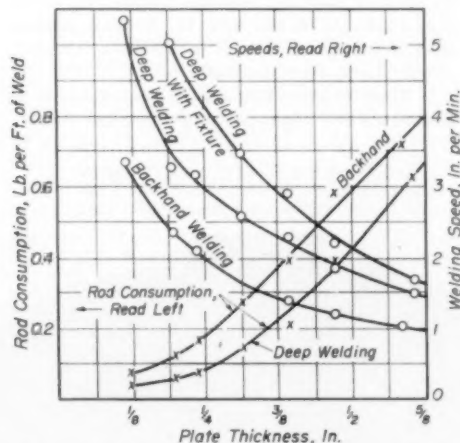


Fig. 2—Welding Speed and Rod Consumption for Deep Welding, in Contrast With Conventional Backhand Welding. Acetylene consumption is closely proportional to rod consumption; and the conversion constant is about 16. For example,  $\frac{1}{2}$ -in. joint, deep welded, requires 0.43 lb. rod per ft. of weld (scaled from curve) and  $0.43 \times 16$  or 7.0 cu.ft. of acetylene per ft. of weld



From the curves for welding speed in Fig. 2 as a function of plate thickness it will be seen that the average speed for plates  $\frac{1}{8}$  to  $\frac{5}{8}$  in. thick is approximately 55% greater with deep welding than with backhand. Curves in Fig. 2 also show rod consumption; deep welding uses about 25% less. Virtually the same saving is obtained in acetylene. The new method therefore leads to a substantial improvement in economy, as shown in Table I.\* Overhead is figured as 50% of the normal labor rate (31¢ per hr.). Acetylene is figured at 1.5¢ per cu.ft.; oxygen at  $\frac{1}{2}$ ¢ per cu.ft.; welding rod at 6¢ per lb.

Table I—Cost Comparisons, \$ per Ft. of Weld

PLATE	DEEP WELD	BACKHAND
$\frac{1}{8}$ in.	\$0.03	\$0.05
$\frac{1}{4}$	0.04	0.08
$\frac{3}{8}$	0.06	0.11
$\frac{1}{2}$	0.08	0.15
$\frac{5}{8}$	0.11	0.19
$1\frac{1}{2}$	0.21	0.31
$2\frac{1}{2}$	0.33	0.45

The figures show that deep welding cuts costs by about one third, and these figures are not the limit. A sample weld was made on

\*EDITOR'S NOTE—Scaled from curves and converted into American units. 1 krona equals 19.35¢.



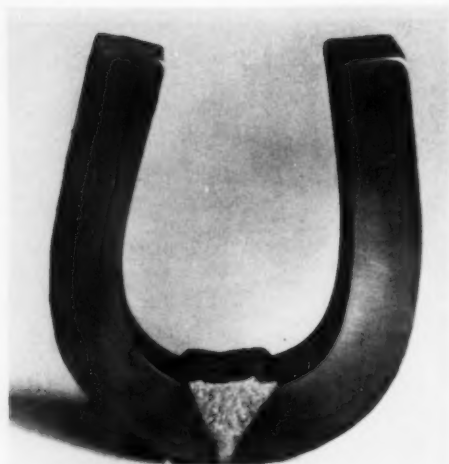


Fig. 4—Cold Bend of Section Cut From Deep-Welded Joint in  $\frac{5}{16}$ -In. Plate (About Full Size)

$\frac{5}{16}$ -in. plate at a speed of 3.8 in. per min. (whereas the average in Fig. 2 calls for 2.6 in. per min.) and gas consumption of 2.1 cu.ft. per ft. of weld (whereas the average curve of Fig. 2 calls for  $0.15 \times 16 = 2.4$  cu.ft.).

Welding speeds can be increased with larger torches using more gas than usual. However, with low-skilled operators the increase in speed will not be in proportion to the increased gas consumption. Unsteadiness in handling the torch, raising or lowering the flame, is relatively more important where larger quantities of gas per unit of time and plate thickness are concerned. To take advantage of larger welding tips without waste of gas, a special tool—a depth-setter—has been developed which permits the flame to be moved along the joint perfectly steadily. In this device a wheel precedes the flame along the joint, and the torch rests on this wheel. A simple finger control steers the wheel. Figure 3 shows an operator using this equipment.

The upper curve in Fig. 2 shows the speed attainable with the depth-setter. Average welding speeds were 30% over ordinary deep-welding speeds and 100% over backhand welding speeds. The acetylene consump-

tion was also increased on the order of 70%.

Deep welding localizes and concentrates the heat at the plate edges; this means that less heat is drawn back into the adjacent plate, and that the weld itself is cooled more rapidly than in conventional welding, thus reducing grain growth and increasing the mechanical strength of the weld metal. Tests have repeatedly corroborated these facts. A correctly made deep weld will readily stand the cold bend test, seen in Fig. 4, a photograph of a joint in  $\frac{5}{16}$ -in. plate. This section also shows the proper weld (reinforcement) on both top and bottom surfaces.

Warpage will be less with deep welding because less heat penetrates the material. The smaller amount of heat means less fatigue of the operator, thereby improving his efficiency.

It will be observed from Fig. 4 and 6 that the penetration is very great. Deep welding thus eliminates cold shuts along the faces of the groove, and as long as due care is taken to fuse the bottom edges it is certain that the faces higher up will be fused. The edges at the bottom will be melted into a pear-shaped enlargement of the gap, as sketched in Fig. 1. This opening should be maintained at constant size and kept immediately beneath the flame. The width of the enlarged gap can be verified by examining the underside of the weld on completion; if it is uniformly enlarged, one can rest assured that the material is fused throughout. Because the quality of a weld can be judged from the appearance of its root-side, the Swedish authorities have waived X-ray examination of deep-welded tanks for some uses.

X-ray examination shows deep welds to be noticeably free from porosity and other defects.

Fig. 5—Partly Finished Joint in Small Pressure Vessel (Gas Container) Showing Line-Up of Joint, Large Gap Under Flame, and Completed Weld



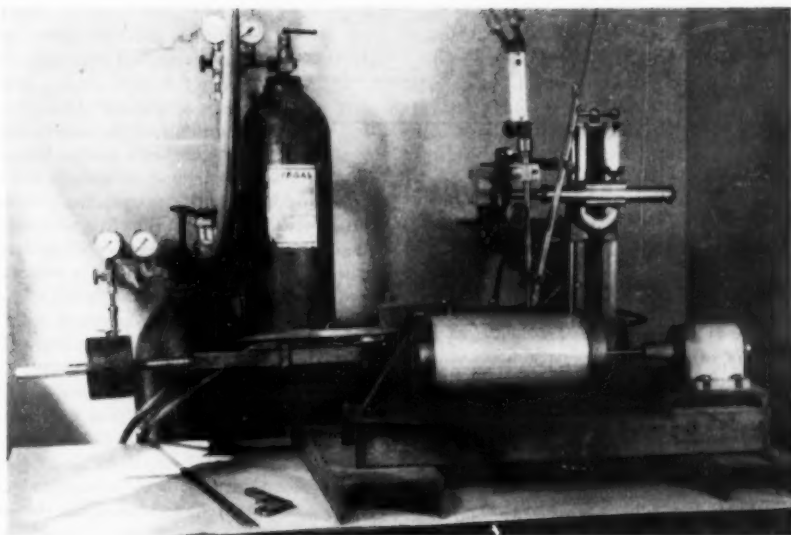


Fig. 6—Machine for Deep Welding Small Cylinders With  $\frac{1}{8}$ -In. Wall. Speeds, up to 12 in. per min.

The mean rating, for example, for 313 deep-welded jackets submitted for X-ray examination to the Swedish Technical X-ray Institute is 4.4 out of a possible 5.0.

#### APPLICATIONS IN SWEDEN

Deep welding finds many applications in Sweden. Figure 5 shows a joint, partly made, on the domed end of a small high-pressure gas cylinder. These cylinders, used for oxygen for anesthetic and other purposes, range in volume from one pint to 0.9 cu.ft., and have wall thickness from 2 to 6 mm. (12 gage to  $\frac{1}{4}$  in.). The material is alloy steel similar to S.A.E. 4130 of the following nominal composition: 0.25% C, 0.70% max. Mn, 0.35% Si, 1.0% Cr and 0.20% Mo.

The sides are of seamless tube. Covers and bottoms are of domed design and welded on, and a nipple is welded into the cover for the gas valve. Thus, there are two main welds around the circumference as well as the small nipple weld. The parts are assembled by small tack welds. The cylinders are then supported on rollers which rotate slowly during the process. The worker can stop the rotation to suit the speed of the operation by a pedal.

This steel has a higher surface energy when liquid than unalloyed steel. As a result the molten metal does not run down to form a ridge beneath the weld-root as quickly. In order to

get a ridge (underside reinforcement) a larger hole must be retained immediately beneath the flame than is otherwise necessary.

After welding is completed the cylinders are normalized and air cooled.

The cylinders are designed for a working pressure of 2100 psi., and are tested to 3200 psi. One chosen at random out of every batch of 200 is tested to destruction, the pressure necessary being of the order of 8500 to 10,000 psi. So far, no weld has broken at this pressure. To date, about 100,000 cylinders of all types made from this alloy steel have been deep welded.

The process is particularly suited to machine welding. Figure 6 shows a welding machine for cylinders with  $\frac{1}{8}$ -in. wall. To melt the welding rod quickly an extra flame is applied. Traveling speeds are much higher than with hand welding, running up to 12 in. per min.

Deep welding of plate thicknesses over  $\frac{3}{8}$  in. has been done by the same techniques as the thinner gages. Lately a special torch has been developed for these heavier thicknesses. In this torch there are two flames placed in tandem. One flame is always about  $\frac{3}{16}$  in. ahead of the actual welding flame; it preheats the edges. By this means a more diffused heat is obtained so there is better control of the molten material. Control of molten material presents no problem with plate thinner than  $\frac{3}{8}$  in., consequently single tips are used.

# Correspondence

## Surface Hardening of Nodular Cast Iron With High-Frequency Currents

OSAKA, JAPAN

High-frequency hardening of cast iron surfaces is usually difficult and unsatisfactory because (a) cast iron is a poor heat conductor as an aggregate; (b) excess ferrite easily precipitates from the austenite on cooling; (c) current densities induced in the two main microconstituents, graphite and ferrite, are quite different, thus causing superheated regions; (d) in high-phosphorus iron, steadite, the fusible Fe-C-P eutectic, may appear.

It is obvious that a reasonably uniform austenite can form much more readily from a fine pearlite with well-disseminated ferrite veins (medium steel) than from a matrix consisting of coarse ferrite and graphite (black-heart malleable)—if for no other reason than the much larger distances over which the carbon atoms must diffuse. An induction hardened malleable iron is shown in Fig. 1. Much of the carbon was undissolved; around these carbon masses are shells of ledeburite (eutectic of iron carbide and saturated austenite, more or less transformed) and martensite. Original hardness of this iron was Rockwell C-5; maximum surface we were

able to get with 20,000 or 30,000-cycle current was C-18, in a layer about 2 mm. deep. One would say, therefore, that the carbon content of the martensite is, on the average, pretty low.

Nodular cast iron would doubtless react to induction hardening much better, especially if the microstructure is the frequent mixture of rounded graphite particles within fairly thin spheres of ferrite, the whole in a matrix of very fine pearlite. Intense and quick heating by induction currents would produce a fairly uniform, high-carbon austenite, the least chance of incipient melting from hot spots, and—on quenching—a uniform martensite of high hardness and a structure free from cracks or micro stress raisers.

This we find, indeed, to be true. Figure 2 is the microstructure of such a hardened case. Its original hardness was about C-25; the induction hardened surface layers, about 3 mm. deep, are now C-60 hard.

Pearlitic malleable is also readily hardenable by induction heating to C-55.

TAKAO TAKASE

Head of Metallurgical Department  
Osaka Institute of Industrial Research

## Russian Metallurgical Texts

SWANSEA, WALES

Dr. Zapffe has presented a lively and most interesting commentary on current metallurgical literature from the U.S.S.R. in last month's *Metal Progress*. I feel, however, that some of his impressions and opinions based thereon call for brief supplementary comment.

In the first place let us see why Russian technical books are so "cheap". Consider a typical example: I have just purchased Okorokov's "Electric Furnaces for Melting Steel", 1950, and have paid for it 8 shillings and sixpence, or just over \$1.00 in U. S. currency. The original price impressed in the left-hand corner on the back cover is 19 rubels 10 kopeikas, and since the official rate of exchange is about 5 rubels per dollar, this book should really cost about \$4.00. Where is this difference coming from? Obviously, from the pocket of the patient Russian taxpayer.

Take it in another way and the spuriousness of this mock-cheapness will come out clearer still. In a minor job which carries in America a salary of \$250 per month, a Russian

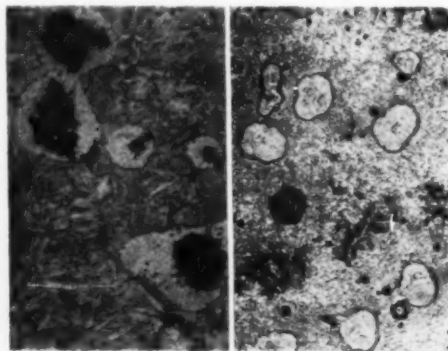


Fig. 1 (Left)—Induction Hardened Shell of a Black-Heart Malleable Iron Bar. Fig. 2 (Right)—Induction Hardened Nodular Cast Iron. Both 250 $\times$ . Microsections prepared and photographed by T. Kusakawa of the castings research laboratory, Waseda University, Tokyo

engineer will get about 600 rubels. The price of the book is therefore less than 1/200 of the American's monthly salary but as much as 1/30 of the Russian's.

This peculiar discount is doubtless a part of the official propaganda policy. Since technical literature forms a minor part of the stock held by the approved book stores, one might wonder whether these are not considered simply as a kind of fly-paper for customers who may later buy "The Short Course of History of the All-Union Communist Party", or as it is called in Russia, "The Fool's Bible". The discount on this book is probably still greater.

I willingly confirm that many Russian textbooks are really very good and useful, but as far as I can see, there is little original in them. The reason why they are so orderly is closely connected with the Russian system of technical education; most of these books are approved university manuals. Wire drawing or stamping, for example, is treated in British or American texts on physical metallurgy in a couple of pages of purely descriptive character. In Russia, on the other hand, one can take a specialized course devoted entirely to such subjects, expanded so that special comprehensive textbooks are required. (Personally, I think that technical education in the U.S.S.R. is sound and very efficient, but I cannot go into details in this brief communication.)

One should not judge the quality of Russian technical books by their degree of saturation with advanced mathematics. While the large number of triple integrals and differential equations is by itself highly impressive, a close examination of the matter will reveal that many of the resulting formulas (very often exceeding 3 in. in length) usually are a smoke screen hiding a vacuum. The number of empirical constants in such equations renders this sky-blown theory entirely pointless — in fact, nobody takes much notice of them, even in Russia, except students and candidates for advanced degrees.

As typical examples one can look up Taits' "Technology of Heating Steel", 1950, and, as I mentioned in my letter published in *Metal Progress* for December 1950, Dobrokhoto, who designed the Mariupol furnaces, was such a brilliant mathematician that nobody could prove his theories wrong until these monsters had been built and failed to produce.

The small number of references to foreign work, noted by Dr. Zapffe, is easily understood. If, say, Ivanov has written a book on stainless steel in 1936 and quoted Monypenny, this is

sufficient. When Petrov is writing on the same subject in 1951 he does not need to quote Monypenny, since not only is Ivanov reliable enough, but additional glory is added to the scientific traditions of the Red Fatherland by ignoring any indebtedness to a foreigner. Recent books (unless they are reprints) and particularly those written since 1948 contain almost exclusively references to Russian work. This is simpler and safer!

Finally, if the Russians really possess such excellent scientists, engineers, and literature, the following questions should not arise:

1. Why have they translated as late as 1948 Seitz's 1943 "Physics of Metals" and Barrett's 1943 "Structure of Metals"? Neither could be considered as up-to-date at the time of translation, and yet it was apparently worthwhile to bring them to Russian metallurgists.

2. Why does the 1949 book on induction heating by Lozinski (a very good book, by the way) contain, as an example of its use in a large forging plant, a shabby reproduction of equipment in the Mullins plant from an American magazine, and not of Russian plant?

3. Would Loskutov's recent pot-boiler on the metallurgy of zinc ever have been translated into German, if the German publisher were in Munich and not in the Soviet Zone?

4. Why does the Molotov Automobile Works in Gorki still produce the 1928 model 1.5-ton Ford truck, without any changes?

These comments must not be considered as a criticism of Dr. Zapffe's review. They are put forward merely with the aim of showing that overestimation of Russian industrial power and intelligence is equally as dangerous as the opposite. From numerous recent publications it appears that the first is now very common.

N. H. POLAKOWSKI  
University College

## Corresponding or Homologous Temperatures

PARIS, FRANCE

Even though "room temperature" has no physical significance, it enters into all our comparisons of properties of different materials for obvious practical reasons. Still, its use as a common point of reference tends to mask those general relationships that one seeks to discern and establish between the properties of metals.

The centigrade scale of temperatures is no better in this respect. This scale, based on the

freezing and boiling points of *water*, can have no relevant bearing on the behavior of *metals*. A proper comparison would be based on thermometric scales related to the behavior of each metal—running, for example, from zero at absolute zero to, say, 100 at its melting point.

This method of construction gives what may be called "corresponding" or "homologous" temperatures. A corresponding temperature thus has the same numerical value at the same fraction of the absolute temperature of melting.

Corresponding temperatures bring out several simple relationships. Tammann pointed out long ago that the absolute temperature of recrystallization is one half the absolute temperature of fusion. In other words, the corresponding temperature of recrystallization is 50.

Corresponding temperatures should reveal some simple relationships among the elastic moduli of metals, for the melting point can be considered as the temperature at which it reduces to zero. We have already pointed out that the elastic modulus  $E$  at room temperature is proportional to the atomic value  $V$  of the metal, provided a correction term for its melting point  $T$  is considered. ( $E$  is approximately equal to  $1000 + 650T/V^2$ .) Again, Mallock claims that the ratio of the modulus at absolute zero to the modulus at  $0^\circ\text{C}$ . is equal to the ratio of the melting point expressed in degrees kelvin to the melting point expressed in degrees centigrade. If this is true, and if the melting point of a metal is expressed as a corresponding temperature—that is, 100—then the temperature coefficient of elasticity of any metal is equal to its elastic modulus at absolute zero.

All metals have the same coefficient of expansion if corresponding temperatures are used (neglecting the ferromagnetic elements) since all metals expand about the same amount from absolute zero to their melting point. The ferromagnetic metals are an exception to this generalization because of the perturbations in the expansion curve below the Curie point.

The looseness of the term "hot tests" can be avoided if one defines them as being performed above the recrystallization temperature—or at a corresponding temperature above 50. Creep curves become comparable for all metals if compared on the basis of corresponding temperatures, as may be seen in Andrade's and Orowan's work.

Further examples, such as diffusion rates and calcination rates, could be cited but this is hardly necessary. The fruitfulness of this approach is obvious.

ALBERT M. PORTEVIN



## The Festival of Britain

BIRMINGHAM, ENGLAND

One of our lathes must have been imbued with the festival spirit when it produced this turning of 18-8 stainless steel during a parting operation at 215 ft. per min. and 0.005-in. feed with a "Stellite 100" tool.

M. RIDDIHOUGH

Technical Manager  
Deloro Stellite Limited

## Acceptance Test for High Speed Tools

ILFORD, ESSEX, ENGLAND

At the Editor's request, I am sending a procedure for testing high speed steel tools, a test used in my work at Ford Motor Co. Ltd. of England for 20 years, and also for many years considered standard by the British Admiralty. It is capable of separating the sheep from the goats among shipments of heat treated tools made from the British Standard analysis, 18% W, 4% Cr, 1% V.

This recommended practice for high speed is briefly as follows:

1. Test each piece for hardness, rejecting all having a Rockwell hardness below C-64.
2. Select 5 to 10% of the accepted tools at random (according to size of lot), heat them in



a salt bath for 1 hr.—more, if the tools are large—at 685° F.  $\pm 10^\circ$ .

3. Cool and retest. If any are softer than before, treat all tools as in 2, and reject any that lose hardness. They are tools which have not been properly treated by the manufacturer.

JOHN GARLAND

Tool Room Foreman (Retired)  
Ford Motor Co. Ltd.

## Carbide Phase in Tempered Steel

NEWCASTLE UPON TYNE, ENGLAND

Readers of *Metal Progress* interested in the nature of the changes when quenched steel is tempered, and who have read Professor Guy's abstract in the June issue (p. 878) of the Russian paper written by M. P. Arbutov ("The Crystal Structure and Particle Size of the Carbide Phase in Tempered Steel"), may wish to know about my own concurrent work on the same subject at the laboratories of the British Iron & Steel Research Assoc., and at Cavendish Laboratory in Cambridge, England. Results will be given in full in the forthcoming September issue of the *Journal of the Iron and Steel Institute* ("Structural Transformations in the Tempering of High-Carbon Martensitic Steels") but the following summaries of the work have already been published:

"Results of Further X-ray Structural Investigations of the Iron-Carbon and Iron-Nitrogen Systems and of Related Interstitial Alloys", in *Acta Crystallographica*, V. 3, 1950, p. 392 to 394.

"New Interstitial Alloy Phases Relating to the Surface Hardening of Steel", in *The Australian Engineer* for November 1950, p. 55 to 61.

Arbutov's observations are similar to the ones recorded in these 1950 papers of mine, and relate to what may be called the third stage of tempering. Our respective interpretations are qualitatively the same. Arbutov's work is incomplete, however, in that there is no mention of the structural changes which occur during the first stage of martensitic decomposition.

(It may not be amiss to point out that the work of Antia, Fletcher and Cohen published in the *Transactions of the American Institute of Mining and Metallurgical Engineers* in 1944 showed that a hardened structure in high-carbon steel consisting of tetragonal martensite and retained austenite would undergo three changes during low-temperature tempering. While it is generally agreed that the second stage consists of the transformation of the retained austenite, the exact nature of the first and third stages has been in dispute, although they certainly are

stages in the separation of cementite and the formation of cubic ferrite.)

My observations on the tempering of martensite may be summarized as follows:

New X-ray observations give direct evidence that the loss of tetragonality of martensite during the first stage of steel tempering is caused by the precipitation of a close-packed hexagonal iron carbide. A proposed name for it is " $\epsilon$  iron carbide", because of its structural similarity to " $\epsilon$  iron nitride". The  $\epsilon$  iron carbide is formed as a coherent transitional phase in which relaxation of the Laue condition for X-ray reflection is a minimum in a direction normal to the (101) lattice planes. The existence of a simple orientational relationship between martensite and the hexagonal carbide is probable.

During the third stage of steel tempering,  $\epsilon$  iron carbide transforms to give a fine dispersion of very thin platelets of cementite, with the planes of the platelets parallel to the (001) lattice planes of the cementite structure. The observed X-ray diffraction pattern is markedly different from that of high-temperature crystalline cementite, as the Laue condition is completely fulfilled only in directions parallel to the (001) plane and is relaxed in the [001] direction. Included among the strongest reflections are those corresponding to previously unidentified X-ray reflections observed by earlier investigators and ascribed by them to a new unknown iron carbide. With increasing tempering times, or at higher temperatures, the gradual growth and recrystallization of the cementite platelets are accompanied by a reduced strain in the matrix.

Each of the two stages of the transition of dispersed carbon in martensite to the iron carbide, cementite (corresponding to the first and third stages, respectively, of steel tempering) can take place by relatively small movements of iron atoms, and the precise nature of these movements is suggested in my publications cited above. The proposed structural changes are correlated with the well-known changes in hardness and specific volume of steel during tempering, and are supported by recent electron-microscope studies.

Cementite platelets similar to those observed in tempered martensites are also obtained in the low-temperature heat treatment of carbonyl-iron powders.

K. H. JACK

Chemistry Dept.

King's College, University of Durham  
Formerly Senior Scientific Officer  
British Iron & Steel Research Assoc.

# ELECTROMET *Data Sheet*

Published by Electro Metallurgical Company, A Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y. In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario.

## ALLOYS FOR THE STEEL, IRON, AND NON-FERROUS INDUSTRIES

PRODUCT *	NOMINAL COMPOSITION	USES	PRODUCT *	NOMINAL COMPOSITION	USES
<b>BORON ALLOYS</b>			<b>CHROMIUM ALLOYS cont.</b>		
<b>Ferroboron</b>	Silicon.....max. 1.50%	Increases hardenability of steel; also, for additions to malleable iron and aluminum alloys.	<b>Foundry Ferrosilchrome</b>	Chromium.....62 to 66%	Developed especially for high-solubility ladle additions of chromium to improve composition and properties of cast iron.
Min. 10.00%	Aluminum.....max. 0.50%			Silicon.....7 to 10%	
<b>Boron Grade</b>	Carbon.....max. 1.50%			Carbon.....5 to 7%	
Min. 17.50%	Silicon.....max. 1.50%	Used to cleanse and deoxidize non-ferrous alloys.	<b>Low-Carbon Grade</b>	Chromium.....50 to 54%	Production of wide variety of non-ferrous chromium-bearing alloys, including electrical resistance alloys and high-temperature alloys.
<b>Boron Grade</b>	Aluminum.....max. 0.50%			Silicon.....28 to 32%	
	Carbon.....max. 0.50%			Carbon.....max. 1.25%	
<b>Manganese-Boron</b>	Boron.....min. 17.50%	Special boron alloy used principally for deoxidizing nickel and its alloys.	<b>Chromium Metal</b>	Chromium.....min. 97%	In production of stainless steels, these alloys are used to reduce metal oxides from the slag back into bath.
	Manganese.....approx. 75%		<b>Low-Carbon Grades</b>	Carbon.....max. 0.10% and 0.50%	
	Silicon.....max. 1.50%			Iron.....max. 1%	
	Carbon.....max. 3%	A complex boron addition agent for increasing the hardenability of steel.	<b>High-Carbon Grade</b>	Chromium.....87 to 90%	For adding chromium and silicon to steels containing up to 1 or 2 per cent chromium.
	Iron.....max. 5%			Carbon.....9 to 11%	
	Nickel.....Balance			Iron.....max. 1.25%	
<b>Boron Carbide</b>	Boron.....45 to 50%	Deoxidizer for non-ferrous alloys.	<b>"EM" Ferrosilchrome-Silicon</b>	Chromium.....39 to 41%	For adding chromium and silicon to steels containing up to 1 or 2 per cent chromium.
	Carbon.....45 to 50%		<b>No. 1 Grade</b>	Silicon.....42 to 46%	
<b>Calcium Boride</b>	Boron.....38 to 42%	Welding rod coating.		Carbon.....max. 0.05%	
	Calcium.....27 to 32%			Chromium.....36 to 39%	
	Carbon.....15 to 20%			Silicon.....36 to 39%	
<b>SILCAZ Alloy</b>	Boron.....0.55 to 0.75%	A complex boron addition agent for increasing the hardenability of steel.	<b>No. 2 Grade</b>	Carbon.....max. 0.05%	
	Silicon.....35 to 40%			Aluminum.....7 to 9%	
	Calcium.....9 to 11%		<b>"EM" Ferrosilchrome-Chrome</b>	Chromium.....50 to 54%	For adding chromium and silicon to steels containing up to 1 or 2 per cent chromium.
	Aluminum.....6 to 8%			Silicon.....28 to 32%	
	Titanium.....9 to 11%			Carbon.....max. 1.25%	
	Zirconium.....3 to 5%		<b>"EM" Chromium Briquets</b> (Hexagonal Shape)	Chromium.....2 lb.	For adding chromium to cast iron in the cupola.
				Total Weight.....3½ lb.	
<b>CALCIUM ALLOYS</b>			<b>COLUMBIUM ALLOYS</b>		
<b>Calcium-Silicon</b>	Calcium.....30 to 33%	Deoxidizer for quality ingot steel. Also used in high-tensile gray irons.	<b>Ferrocolumbium</b>	Columbium.....50 to 60%	Stabilizer in austenitic chromium-nickel stainless steels. Also constituent of high-temperature alloys.
	Silicon.....60 to 65%			Silicon.....max. 8%	
	Iron.....1.50 to 3%			Carbon.....max. 0.40%	
<b>Calcium-Manganese-Silicon</b>	Calcium.....16 to 20%	A complex deoxidizer used widely in production of steel castings.	<b>Ferrotantalum-Columbium</b>	Columbium.....approx. 40%	Another stabilizer, used to supplement ferrocolumbium, in austenitic chromium-nickel stainless steels. Also used in high-temperature alloys.
	Manganese.....14 to 18%			Tantalum.....approx. 20%	
	Silicon.....53 to 59%			Cb + Ta.....min. 60%	
<b>Calcium Metal</b>		Reducing agent in metallurgical applications, deoxidizer and degasifier for non-ferrous metals, particularly magnesium.		Silicon.....4 to 6%	Also used in high-temperature alloys.
<b>Regular Grade</b>	Calcium.....98%			Carbon.....max. 0.30%	
	(Cylinders, Slabs, Cut Pieces, or Turnings)				
<b>Distilled Grade</b>	Calcium.....approx. 99.90%	For special applications requiring calcium of very high purity.			
	(Irregular pieces from pea size to 14 in. lumps)				
<b>CHROMIUM ALLOYS</b>			<b>MANGANESE ALLOYS</b>		
<b>Low-Carbon Ferrosilchrome</b>	Chromium.....67 to 71%	Production of stainless steels and high-temperature alloys requiring low carbon content.	<b>Standard Ferromanganese</b>	Manganese.....78 to 82%	Most common means of adding manganese to steel for both alloying and deoxidizing purposes. Also for counteracting sulphur in steel and cast iron.
	Silicon.....0.30 to 1.00%		<b>Regular Grade</b>	Carbon.....approx. 7%	
	Carbon (10 Grades).....max. 0.03 to max. 2.00%			Silicon.....max. 1%	
<b>High-Carbon Ferrosilchrome</b>	Chromium.....67 to 70%	For production of engineering alloy steels and other alloy steels of moderate chromium content.	<b>Low-Phosphorus Grade</b>	Manganese.....78 to 82%	Additions of manganese to steels of low-carbon specification, particularly stainless steels of 18 per cent chromium, 8 per cent nickel type.
Max. 4.50, 5.00, or 6.00% Carbon Grade	Silicon.....1 to 2%			Carbon.....max. 7%	
Max. 7.00% Carbon Grade	Chromium.....66 to 69%			Silicon.....max. 2%	
Min. 7.00% Carbon Grade	Silicon.....1 to 3%	For additions of nitrogen to improve properties of high-chromium steels.		Phosphorus.....max. 0.10%	
	Chromium.....65 to 68%		<b>Low-Carbon Ferromanganese</b>	Manganese.....min. 90%	
	Silicon.....1 to 3%			Carbon.....max. 0.07%	
<b>Nitrogen-Bearing Low-Carbon Ferrosilchrome</b>	Chromium.....67 to 71%	A high-solubility chromium addition for steel or iron in either furnace or ladle.	<b>Low-Phosphorus Grade</b>	Phosphorus.....max. 0.06%	For making low- and medium-carbon manganese steel and Hadfield steel.
	Silicon.....0.30 to 1.00%		<b>Regular Grades</b>	Manganese.....85 to 90%	
	Carbon.....max. 0.10%			Carbon.....max. 0.07, 0.11 to 0.15, 0.30, or 0.50%	
	Nitrogen.....approx. 0.75%			Carbon.....max. 0.75%	
			<b>Regular Grade (High-Silicon)</b>	Silicon.....5 to 7%	
<b>"SM" Ferrosilchrome</b>	Chromium.....60 to 65%		<b>Medium-Carbon Ferromanganese</b>	Manganese.....80 to 85%	
	Silicon.....4 to 6%			Carbon.....max. 1.25 to 1.50%	
	Carbon.....4 to 6%				
	Manganese.....4 to 6%		<b>Silicomanganese</b>	Manganese.....65 to 68%	A versatile alloy useful as furnace block, deoxidizer, and also for making manganese additions to steel in the ladle or in the furnace.
			<b>Max. 1.50% Carbon Grade</b>	Silicon.....18 to 20%	
			<b>Max. 2.00% Carbon Grade</b>	Manganese.....65 to 68%	
			<b>Max. 3.00% Carbon Grade</b>	Silicon.....15 to 17.50%	
				Manganese.....65 to 68%	
				Silicon.....12 to 14.50%	

\*All of the alloys and metals listed are produced in the usual lump, crushed, or ground sizes, except where other special forms are indicated.

PRODUCT*	NOMINAL COMPOSITION	USES
<b>MANGANESE ALLOYS cont.</b>		
<b>Low-Iron Ferromanganese</b>	Manganese.....85 to 90% Carbon.....approx. 7.00% Silicon.....max. 3% Iron.....max. 2%	For high manganese additions to certain non-ferrous alloys, particularly aluminum.
<b>Manganese Metal</b>	Manganese.....min. 96% Carbon.....max. 0.20% Silicon.....max. 1.00% Iron.....max. 2.50%	Used both as deoxidizer and alloy in production of numerous non-ferrous metals and alloys.
<b>"EM" Silico-manganese Briquets (Square Shape)</b>	Manganese.....2 lb. Silicon..... $\frac{1}{4}$ lb. Total Weight.....3 $\frac{1}{4}$ lb.	For adding manganese (with silicon) to cast iron in the cupola.
<b>"EM" Ferro-manganese Briquets (Oblong Shape)</b>	Manganese.....2 lb. Total Weight.....3 lb.	For adding manganese (without silicon) to cast iron in the cupola.

### SILICON ALLOYS

<b>50% Ferrosilicon</b>		
Regular Grade	Silicon.....47 to 51%	Deoxidizer for most grades of killed or semi-killed steel. Blocking grade specially sized for maximum efficiency.
Blocking Grade	Silicon.....47 to 51%	
Low-Aluminum Grade	Silicon.....47 to 51% Aluminum.....max. 0.40%	
<b>65% Ferrosilicon</b>	Silicon...61.50 to 66.50%	Mainly for production of electrical sheet steel.
Low-Aluminum Grade	Aluminum.....max. 0.50%	
<b>75% Ferrosilicon</b>		Deoxidizer and alloy for production of high-silicon spring and electrical sheet steel. Graphitizing inoculant for cast iron.
Regular Grade	Silicon.....73 to 78%	
Low-Aluminum Grade	Silicon.....73 to 78% Aluminum.....max. 0.50%	
<b>85% Ferrosilicon</b>		Enables meller to add higher percentages of silicon without chilling metal in ladle. Graphitizing inoculant for cast iron.
Regular Grade	Silicon.....83 to 88%	
Low-Aluminum Grade	Silicon.....83 to 88% Aluminum.....max. 0.50%	
<b>90% Ferrosilicon</b>		Permits large additions of silicon without harmful chilling effect.
Regular Grade	Silicon.....92 to 95%	
Low-Aluminum Grade	Silicon.....92 to 95% Aluminum.....max. 0.50%	
<b>Silicon Metal</b>		Additions of silicon to non-ferrous metals, particularly aluminum and copper, to improve physical properties.
Regular Grade	Silicon.....min. 97 or 96% Iron.....max. 1 or 2%	
Purified Grade	Silicon...99.70 to 99.90% Iron.....0.05 to 0.15%	For applications in non-ferrous industry requiring silicon of high purity.
Low-Calcium Grade	Silicon.....min. 97% Iron.....max. 1% Calcium.....max. 0.10%	For the production of high-silicon aluminum alloys where calcium is detrimental.
Low-Aluminum Grade	Silicon.....min. 98% Iron.....max. 1% Aluminum.....max. 0.10%	For the production of silicon-copper alloys where aluminum is detrimental.
<b>"SMZ" Alloy</b>	Silicon.....60 to 65% Manganese.....5 to 7% Zirconium.....5 to 7%	Particularly strong graphitizing inoculant used in making ladle additions to cast iron.

<b>Special Graphitizer</b>	Ferrosilicon Compound	Acts as both deoxidizer and graphitizer in cast iron. Useful in controlling chilling tendencies.
<b>Magnesium-Ferrosilicon</b>	Silicon.....approx. 46% Magnesium...approx. 8.5%	For ladle addition to cast iron to obtain special properties.
<b>Barium-Silicon</b>	Barium.....40 to 50% Silicon.....45 to 55%	For deoxidation of non-ferrous alloys.
<b>"EM" Silicon Briquets (Cylindrical Shape)</b>		
Large Size	Silicon.....2 lb. Total Weight.....5 lb.	For adding silicon to cast iron in the cupola.
Small Size	Silicon.....1 lb. Total Weight.....2 $\frac{1}{4}$ lb.	

"Electromet," "EM," "Silcoz," "SM," and "SMZ," are trade-marks of Union Carbide and Carbon Corporation.

PRODUCT*	NOMINAL COMPOSITION	USES
<b>TITANIUM ALLOYS</b>		
<b>Ferrotitanium</b>	Titanium.....27 to 32% Carbon.....max. 0.10%	For adding titanium to stabilized austenitic chromium-nickel stainless steels and to high-temperature metals.
<b>Silicon-Titanium</b>	Titanium.....40 to 50% Silicon.....45 to 50% Iron.....max. 3%	For additions of titanium to steels or non-ferrous alloys.
<b>Manganese-Nickel-Titanium</b>	Titanium.....43 to 48% Nickel.....approx. 25% Manganese.....max. 8% Aluminum.....max. 18% Iron.....max. 5% Silicon.....approx. 2% Carbon.....max. 0.15%	Deoxidization of nickel alloys.

### TUNGSTEN ALLOYS

<b>Ferrotungsten</b>	Conforming to A.S.T.M. Spec. A 144-39	For production of tool and die steels; also high-temperature alloys.
<b>Tungsten Metal Powder</b>		Production of tungsten steels and cast tungsten carbide.
Melting Grade	Tungsten....min. 98.80% Total Carbon...max. 0.25%	

### VANADIUM ALLOYS

<b>Ferrovanadium</b>	Vanadium.....50 to 55% Carbon...max. 0.20, 0.50, or 3.00% Silicon...max. 1.50, 2.00, or 8%	Production of tool and engineering steels, high-strength structural steels, non-aging rimming steels, and wear-resistant irons.
<b>Vanadium Oxide Fused</b>	V <sub>2</sub> O <sub>5</sub> .....86 to 89% Na <sub>2</sub> O.....approx. 10% CaO.....approx. 2%	For addition of vanadium to steel and for manufacturing catalysts.
<b>Sodium Polyvanadate (Red Coke)</b>	V <sub>2</sub> O <sub>5</sub> .....approx. 85% Na <sub>2</sub> O.....approx. 9% CaO.....approx. 2% H <sub>2</sub> O.....approx. 2.5%	For manufacture of vanadium compounds, including vanadium catalysts.
<b>High-Purity Ammonium Metavanadate</b>	V <sub>2</sub> O <sub>5</sub> .....approx. 99.50% NH <sub>4</sub> VO <sub>3</sub> .....min. 99%	

### ZIRCONIUM ALLOYS

<b>12 to 15% Zirconium Alloy</b>	Zirconium.....12 to 15% Silicon.....39 to 43% Carbon.....max. 0.20%	This zirconium alloy is a powerful deoxidizer. It also increases depth of hardening.
<b>35 to 40% Zirconium Alloy</b>	Zirconium.....35 to 40% Silicon.....47 to 52% Carbon.....max. 0.50%	Deoxidizer for fine grades of alloy steels. Used for adding larger amounts of zirconium.
<b>Nickel-Zirconium</b>	Zirconium.....25 to 30% Nickel.....40 to 50% Aluminum.....approx. 15% Silicon.....max. 10% Iron.....max. 5%	Effective for deoxidizing and degasifying nickel and its alloys.

## IF YOU HAVE A METALS PROBLEM

More than 50 different alloys and metals are produced by ELECTROMET in hundreds of varying compositions and sizes. If you need help in selecting the proper alloys, or have some specific metallurgical problem, be sure to consult one of ELECTROMET's specially trained metallurgists and engineers. Address your inquiries to one of the offices listed below.

Birmingham 3, Ala.....Brown-Marx Building  
Chicago 1, Ill.....230 N. Michigan Avenue  
Cleveland 14, Ohio.....Union Commerce Building  
Detroit 2, Mich.....6-240 General Motors Building  
Los Angeles 58, Calif.....2724 Leonis Boulevard  
New York 17, N. Y.....30 East 42nd Street  
Pittsburgh 22, Pa.....2207 Oliver Building  
San Francisco 6, Calif.....22 Battery Street  
In Canada: Electro Metallurgical Company of Canada Limited, Welland, Ontario

# Personal Mention



**Truman S. Fuller**

TRUMAN S. FULLER, the new president of the American Society for Testing Materials, joined that society and the American Society for Metals at about the same time, in the late 1920's. He has worked for the General Electric Co. since his graduation (B.S. in chemistry) from Syracuse University in 1911, practically all of that time serving as metallurgist in the research laboratory at Schenectady. Since 1945 he has been engineer in charge of the works laboratory. During his 14-year chairmanship of A.S.T.M.'s Committee B-3 on Corrosion, extensive atmospheric tests were conducted. With General Electric his attention was early directed toward the endurance of metals in moist air and steam. Properties of metals at high temperature and the embrittlement of copper also engaged his attention; as one of the original members of the G. E. "Creep Committee" he laid the foundation of what is now called creep-rupture testing, but the work at Schenectady has been extraordinarily diverse, ranging from cemented carbides to die castings to copper to turbine alloys. As to his personal characteristics, one of his associates says "the most outstanding are his honesty and frankness. You know where he stands and why. He backs his men; he plugs for them; they want to work for 'Doc' Fuller. He is by no means stuffy, he is always ready to hear a good story, and try to tell a better one." What better could you say?



**Don M. McCutcheon**

DON M. MCCUTCHEON, a metallurgical engineer who is also a leader in the field of the industrial application of applied physics, has recently been named manager of the physics department of Ford Motor Co.'s new scientific laboratory where research activities in the fields of thermodynamics, physical properties and radiation will be under his direction. Mr. McCutcheon joined Ford in 1935 and has directed the activities of the applied physics unit of the Ford Manufacturing Research Department since 1945. Among the projects he has directed was the development of a successful isotope gage for determining automatically the height of liquid metal in iron foundry cupolas, and an isotope gage which automatically records sheet steel thickness in the cold rolling mill. He received his B.S. degree in chemical engineering from the University of Michigan in 1931, and his M.S. degree in metallurgical engineering two years later. He has served as lecturer for the University's extension course on X-ray diffraction and radiographic inspection, and is a member of the physics advisory committee of Wayne University. Mr. McCutcheon has addressed many technical groups throughout the country and he has published a great number of papers on the subjects of radiography, X-ray diffraction, nondestructive testing and the industrial uses of radioisotopes.



**Nelson E. Cook**

NELSON E. COOK, general superintendent of galvanizing at the Wheeling Steel Corp., Wheeling, W. Va., was recently presented with the 1950 Annual Award of the Galvanizers' Committee of the American Zinc Institute in recognition of his "distinguished service in the field of galvanizing". Mr. Cook, one of the organizers of the Galvanizers' Committee, has served as chairman for five terms and is at present a member of its governing board. He represents the fourth generation of galvanizers in his family, and has been associated with the Wheeling Steel Corp. for 29 years, having succeeded his father, the late William J. Cook, who had been in charge for over half a century, as head of all galvanizing operations for Wheeling. Mr. Cook is a graduate of Cornell University where he received his M.S. degree in chemistry, and he is the holder of numerous patents for galvanizing processes. He has been a member of the American Society for Metals for over 25 years.

**James H. Keeler** has joined the General Electric Research Laboratory, Schenectady, N. Y., as a research associate.

**William L. Frankhouser** has been employed as a metallurgist for Kuhns Brothers Co., Dayton, Ohio.

**Raymond E. Tate** has joined the Los Alamos Scientific Laboratory as a staff member in the chemistry and metallurgy division. He was formerly with Fairchild Engine and Airplane Corp., Hagerstown, Md.



---

## BUSINESS IN MOTION

---

### *To our Colleagues in American Business...*

For several years this space has been used to tell how Revere has collaborated with its customers, to mutual benefit. Now we want to talk about the way our customers can help us, again to mutual benefit. The subject is scrap. This is so important that a goodly number of Revere men, salesmen and others, have been assigned to urge customers to ship back to our mills the scrap generated from our mill products, such as sheet and strip, rod and bar, tube, plate, and so on. Probably few people realize it, but the copper and brass industry obtains about 30% of its metal requirements from scrap. In these days when copper is in such short supply, the importance of adequate supplies of scrap is greater than ever. We need scrap, our industry needs scrap, our country needs it promptly.

Scrap comes from many different sources, and in varying amounts. A company making screw-machine products may find that the finished parts weigh only about 50% as much as the original bar or rod. The turnings are valuable, and should be sold back to the mill. Firms who stamp parts out of strip have been materially helped in many cases by the Revere Technical Advisory Service, which delights in working out specifications as to dimensions in order to minimize the weight of trimmings; nevertheless, such manufacturing operations inevitably produce scrap. Revere needs it. Only by obtaining scrap can Revere, along with the other companies in the copper and brass business, do the utmost possible



in filling orders. You see, scrap helps us help you.

In seeking copper and brass scrap we cannot appeal to the general public, nor, for that matter, to the small businesses, important though they are, which have only a few hundred pounds or so to dispose of at a time. Scrap in small amounts is taken by dealers, who perform a valuable service in collecting and sorting it, and making it available in large quantities to the mills. Revere, which ships large tonnages of mill products to important manufacturers, seeks from them in return the scrap that is generated, which runs into big figures of segregated or classified scrap, ready to be melted down and processed so that more tons of finished mill products can be provided.

So Revere, in your own interest, urges you to give some extra thought to the matter of scrap. The more you can help us in this respect, the more we can help you. When a Revere salesman calls and inquires about scrap, may we ask you to give him your cooperation? In fact, we would like to say that it would be in your own interest to give special thought at this time to all kinds of scrap. No matter what materials you buy, the chances are that some portions of them, whether trimmings or rejects, do not find their way into your finished products. Let's all see that everything that can be re-used or re-processed is turned back quickly into the appropriate channels and thus returned to our national sources of supply, for the protection of us all.

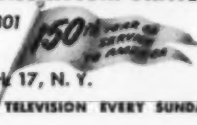
#### REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices:

230 Park Avenue, New York 17, N. Y.

SEE "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY





## Personals

Robert A. Mayer is now civilian chief of the aluminum unit in the Aircraft Production Resources Agency, Wright-Patterson Air Force Base, Dayton, Ohio.

Clyde R. Tipton, Jr., formerly physical metallurgist with the University of California's Los Alamos Scientific Laboratory, has joined the staff of Battelle Memorial Institute, Columbus, Ohio.

Edward B. Westall has returned to the United States after three years in Brazil as chief engineer with Borden Co.'s affiliated company, Alba S/A, and has been assigned as chief project engineer on the new Chemical Division of Borden's plant being built at Demopolis, Ala.

Herbert L. Kee has been employed by Wright Aeronautical Corp., Woodridge, N. J., as a metallurgist. He received his M.S. degree from Pennsylvania State College in June.

Officers of the newly formed National Association of Aluminum Distributors, Cleveland, include Harry L. Edgcomb, Jr., president, T. E. Conklin, vice-president, and Ralph W. Shaw, Jr., treasurer. The association was founded to deal with the problems arising out of the phenomenally rapid growth of the aluminum industry which started just after World War II and has been continuing without signs of a let-up since that time.

W. W. Sieg, president of the Titan Metal Manufacturing Co., Bellefonte, Pa., has been appointed a member of the Brass Mill Industry Advisory Committee of the National Production Authority, Washington, D. C.

N. W. Bass, formerly assistant vice-president of the Brush Beryllium Co., Cleveland, has been promoted to vice-president of the company.

V. H. Ferguson has been elected president of the newly formed Ferguson Equipment Corp., Pittsburgh. He was formerly with the Loftus Engineering Corp., Pittsburgh.

William W. Wellborn has been appointed research engineer of the carbide research and development department of the Firth Sterling Steel & Carbide Corp., Pittsburgh.

Glenn Coley, sales department, Detroit Edison Co., has been presented with the company's Alex Dow Award in recognition of his help in the development of a method to humidify the combustion air used in stoker-fired boilers at the company's power plants.

H. J. Butterill has recently been appointed chief metallurgist and chief inspector for the Arvica (Quebec) Works of the Aluminum Co. of Canada, Ltd.

John H. Alden, who has been with the Aluminum Co. of America for the past 28 years, has recently been appointed chief metallurgist of the Fabricating Division, Pittsburgh.

Harry K. Herschman has been transferred from the National Bureau of Standards to the National Production Authority, Metallurgical and Conservation Branch of the Iron and Steel Division.

Vincent Lysaght has been appointed sales manager of the Helicoid Gage Division, American Chain & Cable Co., Inc., Bridgeport, Conn.

**Why Do More Than 100 Leading Firms Use Sentry HARDENING METHODS?**



Sentry protects pre-cut keenness of teeth on Nicholson's high speed rotary power tools!

Versatility. Sentry Heat Treating Methods are used daily at Nicholson on an almost endless variety of tools.

**REASON** Keeness of Teeth Maintained!

The Nicholson File Company in Providence, R.I., tell us that the SENTRY DIAMOND BLOCK METHOD of heat treating their high speed rotary power tools (hand cut or precision ground) permits them to do a top quality job and to fully maintain pre-cut keenness of teeth. Further, SENTRY gives Nicholson the right heat treating answers on an almost endless variety of sizes and shapes of rotary power and other tools.

Ask for catalog A-5

See you at the National Metal Exposition and Congress in Detroit  
We'll be looking for you at Booth No. A-109.

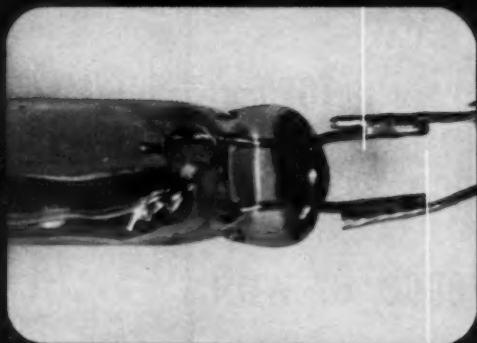
See actual Sentry Furnace in operation. Bring samples to be hardened on the spot

Don't forget the date—October 15-19, 1951



**The Sentry Company**  
INDUSTRIAL ELECTRIC FURNACES AND EQUIPMENT  
FOR HEAT TREATMENT OF METALS  
"Always on Duty" FAYBORO, MASSACHUSETTS

# Now... High Speed Movies of Mechanical Action and Oscillograph Traces Combined on One Film!



These engineers are seeing for the first time what actually happens at the "break" of a mercury switch.

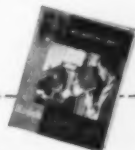


The Kodak High Speed Camera can now be supplied with a special feature which permits the recording of cathode-ray oscillograph traces through the back of the film. This makes possible high speed motion pictures of mechanical action with its electrical aspects simultaneously superimposed *on the same 16mm film*. When projected at normal speed, you get a complete picture of combined mechanical and electrical action slowed down as much as 200 times.



**The Kodascope Sixteen-10R Projector...** To show your high speed movies so that you can study the critical phases of action, this moderately priced projector is equipped with a remote-control push button for reversing film direction over and over again. Its 2-inch *f*/1.6 lens and 750-watt lamp assure bright screen illumination, sharp from edge to edge. Important details stand out clearly, even if exposure conditions have not been optimum.

This basic improvement has countless new applications for solving design, production, and product performance problems through high speed movies, particularly those involving electrical equipment. Since an argon lamp times the film travel, extremely accurate analysis is possible. This unique tool may be the answer for which you have been looking. Further information and a copy of the booklet "Magnifying Time" will gladly be sent on request.



EASTMAN KODAK COMPANY, Industrial Photographic Division, Rochester 4, N. Y.

## High Speed Movies

...a function of photography

# Kodak

TRADE-MARK

whether your product   
must be finished  for  
corrosion resistance  or  
paint  adherence, or with  
eye-appealing brightness   
or in a variety of attractive  
colors, ... there's an  
**IRIDITE®** to do the job!

Zinc, cadmium, aluminum, copper, brass or bronze, in their usual commercial forms, can be finished with Iridite for a fraction of a cent per square foot . . . and without costly special equipment or personnel training. In addition, our ARP plating chemicals . . . brighteners, addition agents, etc. . . can increase the efficiency of your plating solutions prior to Iridite treatment.

Let the experience of our field engineers and laboratory specialists be your guide to the solution of your specific finishing problem.

We'll welcome the opportunity to work with you in the development of new materials as new finishing problems arise from your manufacturing plans. Write for information, or send samples of your product for free test processing.

Iridite is approved under government specifications.



**ALLIED RESEARCH PRODUCTS**  
INCORPORATED

4004-06 E. MONUMENT STREET • BALTIMORE 5, MD.

REPRESENTATIVES IN PRINCIPAL INDUSTRIAL CITIES: West Coast & S. E. DISTRICT COMPANY  
Manufacturers of Iridite Finishes

## Personals

M. R. Gallo, formerly with Clark Bros. Co., Inc., Olean, N. Y., is now representing the Bufllovak Equipment Division of Blaw-Knox Co., Buffalo, N. Y.

Jay O. Mack has been transferred from his position as supervising technologist, metallography and silicon steels, Research and Development Laboratory, United States Steel Co., Pittsburgh, to that of chief control and development metallurgist in the company's Fairless Works, Morrisville, Pa.

A. S. Cogan has been appointed to the ammunition department of the Research and Development Division, Olin Industries, Inc., New York. He was formerly general supervisor of metallurgical and chemical laboratories in the New Departure Division, General Motors Corp., Bristol, Conn.

Phillip R. Kalischer, metallurgist and development engineer, has been appointed associate editor of *Precision Metal Molding* (formerly *Die Castings*) magazine, Cleveland. He was formerly chief engineer in charge of laboratory research on the production of ultra high purity beryllium with Brush Beryllium Co., Cleveland, and with Firestone Tire and Rubber Co., Akron, Ohio, on gun and projectile design and research.

James R. Coxey, formerly assistant professor of metallurgy at Pennsylvania State College, has taken a position as chief of the metals section in the office of the Deputy Chief of Staff, Materiel Headquarters, United States Air Force, Washington, D. C.

Robert Zanoni has been employed on the training program for engineers in the Components Laboratory Division, Detroit Arsenal, Center Line, Mich.

Henry F. Keller, Jr., has been employed as a metallurgist by American Radiator and Standard Sanitary Corp.'s Plumbing Research Division, Louisville, Ky.

Frederick Jackson, formerly metallurgist with the Riverside Metal Co., Riverside, N. J., is now a metallurgist with Kaiser Aluminum and Chemical Corp., Newark, Ohio. He is assigned to the wire department.

**KLOSTER'S**

**"PURE-ORE"**

TRADE MARK REGISTERED U. S. PAT. OFFICE

**FINE TOOL STEELS**

THERE IS A KLOSTER PURE-ORE TOOL STEEL FOR EVERY TOOL AND DIE PURPOSE

*Hundreds of Sizes*



REG. U. S. PAT. OFF.

(A Section of our Chicago Warehouse)

**KLOSTER STEEL CORPORATION**

224-28 N. JUSTINE STREET

CHICAGO 7, ILLINOIS

All Phones MAymarket 1-3450

### SUPERDIE

High Carbon,  
High Chrome,  
Oil Hardening

### ATMODIE

High Carbon,  
High Chrome,  
Air Hardening

# STAR *Die-Steel* PERFORMERS

### OILDIE

Non-Deforming  
Extra Quality

### EXL-DIE

Standard,  
Non-Deforming



## COLUMBIA TOOL STEEL COMPANY

Main Office & Works — Chicago Heights 4, Illinois

There are Columbia warehouses and highly trained Columbia representatives in principal cities. For service, for quality, look to Columbia—producers of fine tool steel by the electric process.

### EZ-DIE

Air Hardening,  
(Cr 5.5%)

## Personals

Joseph B. Darby, Jr., a June graduate of Virginia Polytechnic Institute, has been employed as a metallurgical engineer in the process and product development department of the National Carbon Co., Niagara Falls, N. Y.

Joseph F. Boyce has been appointed eastern sales manager, with offices in Newark, N. J., for the Cyclone Fence Division, American Steel and Wire Co.

Douglas H. Polonis has been employed by the Steel Co. of Canada, Hamilton, Ont., and is taking the company's engineering training course. He graduated from the University of British Columbia in May.

John A. Milko, formerly with Battelle Memorial Institute, Columbus, Ohio, has been employed as a metallurgist, and Eugene E. Hoffman, from Sibley Machine and Foundry Corp., South Bend, Ind., and William C. Hagel, a recent Cornell graduate, have been employed as junior metallurgists by the Union Carbide and Carbon Corp., Oak Ridge National Laboratory, Oak Ridge, Tenn.

William K. Rogers, a March graduate of the Michigan College of Mining and Technology, has been employed in the metallurgical laboratory, Barber-Colman Co., Rockford, Ill.

D. A. Stewart has retired from his position as a director of Serck Tubes Ltd., Birmingham, England, and is taking up residence in Scotland.

James D. White, Jr., and Ralph A. Williams have been appointed president and general manager, and assistant general manager, respectively, of Darwin & Milner, Inc., Cleveland.

Roy E. Swift has joined the faculty of the department of mining and metallurgical engineering, University of Kentucky, Lexington. Dr. Swift was formerly on the staff of the Mackay School of Mines of the University of Nevada, Reno.

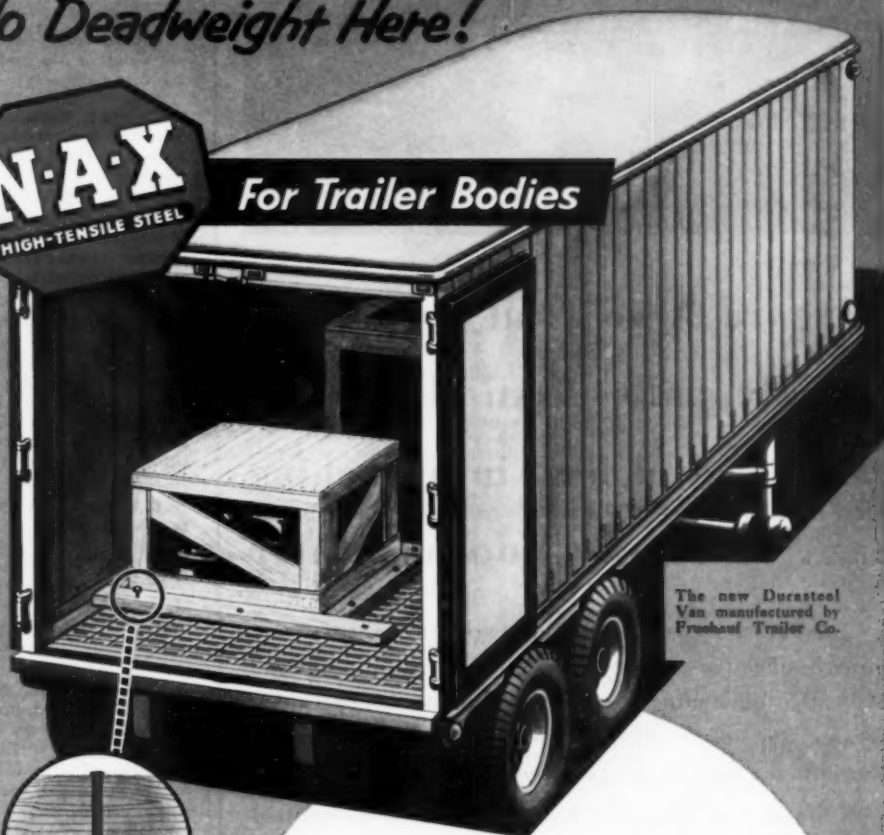
Edwin J. Soxman has been employed as a research associate on an Air Force project, Alfred University, Alfred, N. Y., since he graduated from Missouri School of Mines in May.



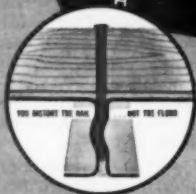
# No Deadweight Here!



## For Trailer Bodies



The new Durasteel Van manufactured by Fruehauf Trailer Co.



"Great Lakes" Stran-Steel Flooring has high strength and light weight. Its unique ribability permits safe blocking of loads. You distort the wall . . . not the floor.

America's first all-steel trailer body is on the highways—roof, sides, framing and flooring, all of N-A-X HIGH-TENSILE steel. Years of planning, testing and research went into this unique trailer body, making it the most serviceable ever built.

1. The use of N-A-X HIGH-TENSILE steel in this equipment results in light weight with strength and durability.
2. In addition to greater strength, N-A-X HIGH-TENSILE steel has greater resistance to fatigue, impact, corrosion and abrasion. It offers a greater strength-to-weight ratio with longer life and larger payloads.

More and more of America's highway equipment manufacturers are swinging to N-A-X HIGH-TENSILE steel. Millions of on-the-job miles have proved the superior qualities of this steel . . . have proved its over-all economy.

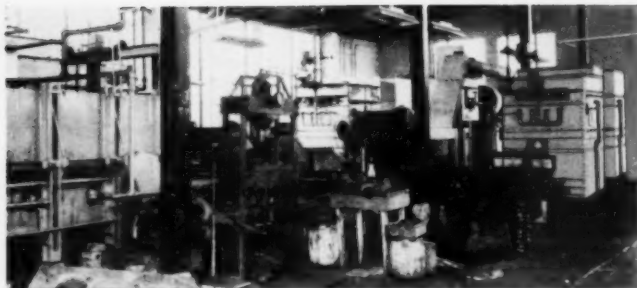
### GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division • Ecorse, Detroit 29, Michigan



### NATIONAL STEEL CORPORATION





## Niagara Aero Heat Exchanger quickly pulls down the initial peak load of heat in quenching ... and saves cooling water

Accurate control of quench bath temperatures and quickly effective capacity to handle the initial peak load of heat in quenching prevents production set-backs, increases the output of your heat treating department, prevents oil fires, saves you losses from rejected parts.

Niagara Aero Heat Exchangers give you this control in both furnace and induction hardening methods. They prevent both over-heating and over-cooling of the quench bath. Hundreds of heat treaters know they prevent many troubles, constantly improve quality and increase production.

They quickly pay for themselves by saving cooling water coils and extend your quench capacity without extra water or cooling tower.

*Write for Bulletin #120 giving complete information.*

**Visit Niagara's Booth G-422 — National Metal Exposition**

### NIAGARA BLOWER COMPANY

Over 35 Years' Service in Industrial Air Engineering


Dept. MP, 405 Lexington Ave.



New York 17, N. Y.



*Experienced District Engineers in all Principal Cities*


## Personals


The American Society for Testing Materials has made the following announcements:



**Harold H. Morgan** , vice-president and general manager of the Robert W. Hunt Co., Chicago, was awarded A.S.T.M.'s Certificate of Honorary Membership in recognition of his notable work in various phases of the Society's work involving standardization and research in materials.


**D. S. Clark** , and **P. E. Duwez** , California Institute of Technology, have received A.S.T.M.'s Charles B. Dudley Medal for their paper, "The Influence of Strain Rate on Some Tensile Properties of Steel". This medal is presented for a paper of outstanding merit constituting original contributions on engineering materials research.

**R. L. Templin** , and **W. C. Aber** , Aluminum Co. of America, received A.S.T.M.'s Richard L. Templin Award for their paper, "A Method for Making Tension Tests of Metals Using a Miniature Specimen". This award is presented for a significant paper describing new testing methods and apparatus.

**C. T. Evans, Jr.** , the Elliott Co., was awarded the Sam Tour Award for his paper, "Oil Ash Corrosion of Metals at Elevated Temperatures". This award is presented for the purpose of encouraging research on the improvements and evaluation of corrosion testing methods and to stimulate the preparation of technical papers in this field.

**Hyman Bornstein** , chief technical consultant, Deere and Co., Moline, Ill., has received an Award of Merit from A.S.T.M. in recognition of his long-time, constructive service to the Society, notably in the fields of cast and malleable iron.

**John W. Bolton** , director of metallurgical research and testing, Lunkenheimer Co., Cincinnati, and **F. P. Zimmerli** , chief engineer, Barnes-Gibson-Raymond Division of Associated Spring Corp., Detroit, have been elected members of the board of directors by A.S.T.M.

**R. H. Noderer** , recently retired after 47 years of service with U. S. Steel Co. subsidiaries. He has been employed for the past 41 years at what is now the Johnstown Works, U. S. Steel Co., the last 15 years as chief metallurgist.

# BORON STEEL

## Table of Contents

It's Later Than You Think, Editorial, *Metal Progress*  
Saving Precious Alloys by Intelligent Use of Alternatives  
Round Table Discussion, Western Metal Congress  
Boron Steels, by Panel on Conservation,  
Metallurgical Advisory Board, *D. L. McBride*, secretary  
A.I.S.I. List of Tentative Standard Boron and Alternate Steels

## Record of Experience With Boron Steels

Historical Development of Boron Additions,  
*by Robert S. Archer*  
Summary of Wartime Investigations of Boron in Steel,  
*by Murray C. Udy*  
Use of Boron Steel in Production of Hand Tools,  
*by Fred J. Robbins and J. J. Lawless*  
Caterpillar Tractor Co.'s Experience with Boron Steels,  
*by John Parina, Jr.*  
Special Carburizing Steels, Boron Treated, *by Porter R. ...*

## Supplement on Hardenability Test and Use

Standard Hardenability Test  
Appraisal of Steels by Their Hardenability,  
*by Walter E. Jomine*  
Hardenability Control for Alloy Steel Parts,  
*by A. L. Borgehold*

\$1.00 per Copy

Published by

**American Society for Metals**  
(The Engineering Society of the Metals Industry)  
7301 Euclid Ave., Cleveland 3, Ohio

Order promptly  
before edition  
is exhausted

# Here's how Pangborn Solves these Problems with this modern equipment

## BLAST CLEANING!



**Blast Cleaning Cabinet** quickly and easily cleans rust, grime, dirt, paint, etc., from metal parts. Produces a clean, smooth surface on pieces up to 60" x 36". Models available from \$315.00 and up.



**Blast Cleaning Machine** not only removes rust, dirt, scale, etc., but is ideal for maintenance and many other uses. Cleans large objects such as bridges, structural work, tanks before painting. Six sizes, portable or stationary, from \$170.00 and up.



## DUST COLLECTING!

**Unit Dust Collector** stops dust at its source, minimizes machine wear and tear, reduces housekeeping and general maintenance costs. Solves many grinding and polishing nuisances. Reduces material losses. Models from \$286.00 and up.



## PRECISION FINISHING!

**Hydro-Finish Cabinet** uses liquid blast, eliminating dust, and reduces costly hand polishing, cleaning and finishing of molds, dies, tools, etc. Removes scale, discoloration and directional grinding lines, prepares surfaces for plating and coating. Holds tolerances to .0001". Models from \$1295.00 and up.

LOOK TO PANGBORN  
FOR THE LATEST DEVELOPMENTS IN BLAST  
CLEANING AND DUST  
CONTROL EQUIPMENT

# Pangborn

MAIL COUPON for full details

(Check for more information)

- ☐ Blast Cleaning Cabinets
- ☐ Blast Cleaning Machines
- ☐ Unit Dust Collectors
- ☐ Hydro-Finish Cabinets

PANGBORN CORP., 1800 Pangborn Blvd., Hagerstown, Md.

Gentlemen: Please send me more information on the equipment I've checked at the left.

Name.....

Company.....

Address.....

City.....Zone.....State.....

## Personals

T. R. Graham ☉ has been transferred from his position as chief of the Metallurgy Branch, Rolla, Mo., to chief of the Physical Metallurgy Branch, College Park, Md., by the Bureau of Mines.

Charles B. Coburn ☉, associated with the United States Steel Co. for many years, has joined the Chicago district sales office of Heppenstall Co., Pittsburgh.

Carl M. Loeb, Jr., ☉, president of Climax Molybdenum Co., New York, has become a member of the Board of Sponsors of the American Baseball Academy, New York, a new organization formed to combat juvenile delinquency in metropolitan areas.

Earl Brodhag ☉ has been appointed development engineer for the American Wheelabrator and Equipment Corp., Mishawaka, Ind. He was formerly a manufacturer's agent for Vapor Blast Manufacturing Co., Milwaukee.

Donald L. Swanson ☉ graduated from Iowa State College in June and is now working at Experiment, Inc., Richmond, Va., as a research engineer.

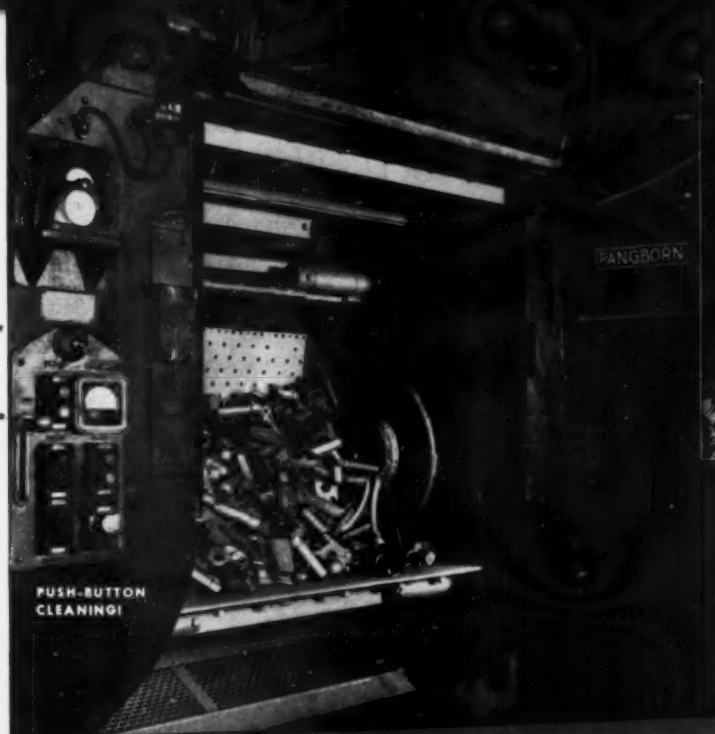
John P. Nielson ☉, associate professor of metal science, New York University, has been appointed to direct the Department of the Army contract awarded the University covering research projects on titanium.

Howard R. Palmer ☉ and William P. Roe, Jr., ☉, have been employed by the National Lead Co., Titanium Division, South Amboy, N. J., as metallurgists.

William A. Cheesebrough ☉ has been a trainee at Inland Steel Co., East Chicago, Ind., since his graduation from Carnegie Institute of Technology in June.

Michael F. Stavich ☉, a recent graduate of Carnegie Institute of Technology, is now a staff member of the fusion joining department of the Metallurgical Research Division, Kaiser Aluminum and Chemical Corp., Spokane, Wash.

Arthur T. Morgan ☉ has been employed as a metallurgical engineer, training at Inland Steel Co., Indiana Harbor, Ind., since his graduation from Purdue University.



PUSH-BUTTON  
CLEANING!



MECHANIZED LOADING!



SIMPLIFIED UNLOADING

These action photographs  
prove Pangborn ROTO-

BLAST Barrels are easy to operate. This 14' ROTOBLAST Barrel is shown in use at the Frick Company. It speeds cleaning by replacing four old-style machines and a secondary pickling operation. And with this machine two men can clean half the entire foundry's output—at an annual saving of \$2540.00 on labor!

## ROTOBLAST . . .

**SAVES LABOR** with push-button operation

**SAVES SPACE** because machines are compact

**SAVES TIME** by cleaning more loads per day

**SAVES POWER** since no compressor is needed

**SAVES TOOLS** because all scale is removed

Here's How

# Pangborn ROTOBLAST\* Barrels SPEED DEFENSE PRODUCTION!

**SPEED** is essential to defense production . . . and in case after case, Pangborn ROTOBLAST Barrels have proved they can clean castings up to 24 times faster than conventional equipment. Even loading is fast! With Pangborn automatic loading equipment, any size ROTOBLAST Barrel (from 3½ to 28 cubic feet) can be loaded in one minute or less!

What's more, Pangborn ROTOBLAST Barrels assure high-quality cleaning. The exclusive "rocking" action of the Barrel exposes all surfaces to the blast stream . . . makes sure pockets of intricate pieces are

completely cleaned. And ROTOBLAST Barrels cost less to operate. Horsepower requirements average 87% less, smaller crews are needed and automatic abrasive recovery assures maximum economy.

**FOR FASTER BLAST CLEANING** install Pangborn ROTOBLAST Barrels in your cleaning room. Bulletin 213 gives you full details, specifications and actual performance as reported by users. Write today to: PANGBORN CORP., 1800 Pangborn Blvd., Hagerstown, Md.

Look to Pangborn for the latest developments in Blast Cleaning and Dust Control equipment.



# Pangborn

## BLAST CLEANS CHEAPER

with the right equipment for every job

\*Trademark of the Pangborn Corporation



# COMPARE

your present

## ALUMINUM FINISHING PROCESS

with these advantages of

**IRIDITE® Al-Coat**

—see for yourself why more and more finishers of aluminum products are specifying Iridite Al-Coat for any wrought, cast or buffed aluminum part.

### 1. IN PROCESSING

**Faster**—Just one simple dip, 10 seconds or only two minutes, depending upon your finishing specifications. No sealing dip, no special drying.

**Simpler**—Non-electrolytic, no heating or exhaust units, operates at room temperature. No special precleaning baths required.

### 2. IN APPEARANCE

**Clear**—Protects metal without changing its original appearance.

**Colored**—Heavier, iridescent yellow film provides greater protection.

### 3. IN PERFORMANCE

**Corrosion Resistance**—Up to 1,000 hours salt spray on wrought stock, 250 hours on castings. Approved under government specifications.

**Abrasion Resistance**—Will not flake or peel from buffing, bending or scraping.

**Paint Base**—Blocks underfilm corrosion; grips paint, holds it firmly.

**Welding**—Finished surface can be spot welded, coating actually aids shielded arc welding.

**Conductivity**—Offers low surface resistance to electrical current.

### 4. IN COST

Comparative figures show that Iridite Al-Coat saves as much as 50% over other aluminum finishing processes. Let us prove this to you.

Write today for FREE SAMPLES of Iridite Al-Coat. Or, send samples of your product for test processing.

Iridite is approved under government specifications.



**ALLIED RESEARCH PRODUCTS**  
INCORPORATED

4004-06 E. MONUMENT STREET • BALTIMORE 5, MD

REPRESENTATIVES IN PRINCIPAL INDUSTRIAL CITIES, West Coast: L.H. BUTCHER COMPANY  
Manufacturers of Iridite Polishes  
The Chemical Industries and Equipment Co., 1000 Pioneer Building, Allentown, Pa.

## Personals

Earl J. Gossett ☼, founder and president of Bell & Gossett Co., Morton Grove, Ill., has been elected to the board of directors of the Oil Heat Institute of America.

M. Brezin ☼ has been promoted from assistant chief metallurgist to chief metallurgist of the Homestead (Pa.) District Works, United States Steel Co.

Richard J. Haffeman ☼ has been employed as a metallurgical engineer trainee at Deere & Co., Moline, Ill., since his graduation from University of Wisconsin in June.

John W. Yeasley ☼ has been employed as an engineering trainee by the Aluminum Co. of America, Vancouver Works, since his graduation from the University of Washington in February.

R. M. Dyke ☼, formerly active in technical-vocational education in British Columbia and Alberta, has joined the editorial staff of *Machine Production* magazine, Toronto, Ont.

Paul J. Hagelston ☼, formerly head of the materials laboratory, Carbide and Carbon Chemicals Co., Oak Ridge, Tenn., is now with the Production Branch, Technical and Production Division, Savannah River Operations Office, U.S. Atomic Energy Commission, Aiken, S. C.

J. Jarms ☼ has recently joined the C. B. Herrick Co., Cleveland, as assistant sales manager. He was formerly a welding engineer in the jet division, Thompson Products, Inc., Cleveland.

R. K. Rarick ☼, formerly metallurgist and welding engineer in the Bendix Products Division, Bendix Aviation Corp., South Bend, Ind., has been promoted to superintendent of special processes in the company's newly established Hamilton Division, Hamilton, Ohio.

Ernest G. Kendall ☼ has accepted a position as metallurgical engineer for Titanium Metals Corp. of America, Henderson, Nev.

Howard Heineke ☼ has been employed in the general laboratories of the Reduction Department, Great Falls, Mont., of Anaconda Copper Mining Co., since his graduation from the University of Kentucky in June.

**Nothing takes  
the place of  
Chromel  
Alumel  
thermocouples**



When you're working with heat between 1000° and 2000° F. and accurate temperature measurement is essential to the results you want to produce, you'll find there is no suitable substitute for Hoskins CHROMEL-ALUMEL thermocouple alloys. They're unconditionally guaranteed to register true temperature—E.M.F. values within very close specified limits. Exceptionally durable . . . so resistant to oxidation that you need not pack the protection tube. Hence, highly responsive to temperature fluctuations. And, in spite of hard use, they maintain their fine degree of accuracy over far

longer periods of time than any other known base metal thermocouple materials.

So for positive long-life assurance of accurate temperature measurement, insist that your pyrometers be calibrated for CHROMEL-ALUMEL thermocouples. And important, too . . . be sure you use CHROMEL-ALUMEL extension leads instead of so-called "compensating" wires. For, when the couple and the lead are of identical alloy compositions there is no possibility of "cold-end" errors. Our Catalog 59-R contains a complete technical explanation . . . want a copy?

*CHROMEL-ALUMEL couples and leads are available through your instrument manufacturer or pyrometer service company . . . ask for them by name!*



**HOSKINS MANUFACTURING COMPANY**

4445 LAWTON AVE. • DETROIT 8, MICHIGAN

NEW YORK • CLEVELAND • CHICAGO

West Coast Representatives in Seattle, San Francisco, Los Angeles  
In Canada: Walker Metal Products, Ltd., Walkerville, Ontario

*\*the nickel-chromium resistance alloy that first made electrical heating practical*

# Reduce your refractory Costs with...



## Johns-Manville FIRECRETE\*

**CAST YOUR OWN** refractory shapes and linings with J-M Firecrete. Burner blocks, door linings, covers, crucibles and countless special shapes are ready for use within 24 hours. Minimum drying shrinkage and firing shrinkage with high resistance to spalling reduce shut-downs—*increase production—lower operating costs.*

**3X Firecrete**—3000F Refractory Concrete—for casting burner blocks, door linings, crucible furnaces, complete linings and special shapes that are subjected to *soaking temperatures of 3000F.*

**H. T. Firecrete**—High Heat Duty Refractory Concrete—especially developed for casting shapes and linings exposed to temperatures between 2400F and 2800F.

**Standard Firecrete**—Intermediate Heat Duty Refractory Concrete—for furnace door linings, bottoms, covers, pipe linings and other types of monolithic constructions as thin as 1 1/2". For temperatures up to 2400F.

**L. W. Firecrete**—Insulating Refractory Concrete—a lightweight, easily applied, low conductivity refractory for furnace bottoms, door liners, covers and special shapes of all descriptions. For direct exposure to 2400F.

\*Reg. U. S. Pat. Off.

## Johns-Manville BLAZECRETE\*

**BUILD AND REPAIR** refractory linings with J-M Blazecrete. Just mix with water—*flip into place and trowel smooth or, "gun" it on. Immediate firing unnecessary. Ready for use after overnight curing.*

**3X Blazecrete**—3000F Hydraulic Setting Refractory—for heavy patching by troweling. Applied by just "flipping" into place. Also for gun application. Particularly adapted for lining ladles, runout spouts, and patching above slag line in cupolas. For soaking temperatures to 3000F.

**Standard Blazecrete**—Intermediate Heat Duty Hydraulic Setting Refractory—used for slap-troweling or gunning. Builds and repairs refractory linings up to 2400F.

**L. W. Blazecrete**—Hydraulic Setting Insulating Refractory for slap troweling or gunning—a lightweight, low-conductivity refractory designed for temperatures to 2000F. It can be used in combination with Standard or 3X Blazecrete, for special conditions.

For further information, write  
Johns-Manville, Box 290,  
New York 16, N. Y.



## Johns-Manville REFRACTORY PRODUCTS

## Personals

Myron P. Davis ☉ has retired from his position as chief chemist and metallurgist, Otis Elevator Co., Yonkers, N. Y.

James T. Kemp ☉ has transferred from his position as metallurgical engineer for American Brass Co., San Francisco, to the Defense Minerals Administration, U. S. Bureau of Mines, Washington, D. C.

James T. MacKenzie ☉, technical director of American Cast Iron Pipe Co., Birmingham, Ala., is the 1951 winner of the Hertzy Medal, sponsored by the Chemistry Club of the Georgia State College for Women and administered by the American Chemical Society, for his research in metals.

Wayne R. Rawlings ☉ has accepted a position as metallurgist in the metallurgical laboratory of Bell and Howell Co., Chicago.

Recent appointments to the staff of the Metallurgical Division of the Oak Ridge National Laboratory, operated by Carbide and Carbon Chemicals Co., Oak Ridge, Tenn., include Thomas K. Roche ☉ as metallurgical assistant, and Joseph F. Delaney ☉ as junior metallurgist. Both men are recent graduates of the University of Notre Dame, South Bend, Ind.

Oliver Smalley ☉, president of the Mechanite Metal Corp., New Rochelle, N. Y., has been elected an honorary life member of the Institute of British Foundrymen, London, in recognition of his services to the foundry industry over a long period of years.

I. Melville Stein ☉, formerly associate director of research for Leeds & Northrup Co., Philadelphia, has been elected executive vice-president to the company's newly created post.

George T. Jones ☉ has been promoted to the position of metallurgical engineer, and R. W. Steigerwalt ☉ has been appointed metallurgical adviser of United States Steel Co.'s railroad materials and forgings division, Pittsburgh. Carl W. Tuttle ☉ succeeds Mr. Jones in his position as assistant metallurgical engineer, and James R. Hamilton ☉ has been appointed senior service metallurgist, railroad materials and forgings division, in the company's Chicago office.

specially  
made  
for  
you

There are no finer steels  
than JESSOP makes

HIGH SPEED STEELS  
HIGH SPEED AND CAST ALLOY STEELS  
HOT WORK AND ALLOY SAW STEELS  
COLD WORK DIE STEELS  
CARBON AND ALLOY STEELS  
STAINLESS AND  
HEAT RESISTING STEELS  
VALVE STEELS  
STAINLESS-CLAD STEELS  
CAST-TO-SHAPE STEELS  
COMPOSITE TOOL STEELS  
ARMOR PLATE

When you buy Jessop  
special steels you buy  
the finest and you save  
because each batch is  
formulated to your exact  
need. There are no ware-  
house steels at Jessop.

# JESSOP

STEEL COMPANY • WASHINGTON, PENNSYLVANIA

- ★ **ARCALOY** for stainless steel
- ★ **ARMOR-ARC** for armor welding
- ★ **BRONZE-ARC** for bronze and cast iron
- ★ **WELD-ARC** for low hydrogen electrodes
- ★ **NICKEL-ARC** for cast iron
- ★ **TOOL-ARC** for tool steel
- ★ **WEAR-ARC** for hard facing



## NAMES TO REMEMBER IN ARC WELDING

# 100%

of all Alloy Rods production is still being sold

through our fine Distributor organization. We are shipping more alloy arc welding electrodes than ever before... and while our Distributors may temporarily be out of stock on certain types, we urge you to keep in touch with them on your requirements. After all, quality is always worth waiting for.

### ALLOY RODS COMPANY

*No Finer Electrodes Made... Anywhere*

YORK, PENNSYLVANIA



★ See your nearest Alloy Rods Distributor



AR-2



# METAL PROGRESS BULLETIN BOARD

THE BUYERS' GUIDE FOR METALS ENGINEERS



131	ABRASIVE PRODUCTS	131	NONFERROUS METALS
131	CASTINGS & CAST FIXTURES	132	PLATING SUPPLIES
132	CLEANING & FINISHING	141	PRESSES, METALWORKING
136	CONTROL INSTRUMENTS	136	PYROMETER SUPPLIES
134	HEATING EQUIPMENT	142	SPINNINGS & STAMPINGS
137	HEAT TREATING SERVICES	142	SPRING MATERIALS
134	HEAT TREATING SUPPLIES	141	STEEL & IRON
134	INDUCTION HEATING	133	SURFACE PROTECTION
139	INSPECTION EQUIPMENT	136	TEMPERATURE CONTROL
136	INSTRUMENTS and CONTROL	139	TESTING EQUIPMENT
139	LABORATORY EQUIPMENT	139	TESTING SERVICES
142	METAL POWDERS	141	TOOLS and TOOL STEELS
141	METALS and METAL FORMS	143	WELDING SUPPLIES



*This year's* **METAL SHOW**  
**IS EVERYBODY'S BUSINESS**

---

Nation-wide . . . world-wide . . . is the impact of the 1951 Metal Show . . . for never before have so many humans looked to the metal industry for the skill . . . the ingenuity . . . the resourcefulness that must be marshaled behind the free world's urgent need for the weapons of defense against a common enemy. That's why this finest and most important Metal Show looms as the vital and timely thing it is . . . a great industry's stirring answer to a world-wide challenge. Be there . . . all the men who make the metal industry what it is will be there, too.

**DETROIT  
MICH.  
Oct. 15-19**

★  
**NATIONAL METAL  
EXPOSITION**

★  
**NATIONAL METAL  
CONGRESS**

★  
**WORLD  
METALLURGICAL  
CONGRESS**



## MANHATTAN

**Abrasive Wheels — Cut-off Wheels  
Finishing Wheels—Diamond Wheels**

Custom-made for your specific material removal problems

**Foundry Snagging—Billet  
Surfacing—Centerless Grinding  
Cutting and Surfacing** concrete, granite, and marble

"Moldiscs" for rotary sanders

**Grinding and Finishing** stainless steel welds

**Bearing Race Grinding** and Finishing

**Finishing Tools and Cutlery**

**Cutting-off**—Wet or Dry Bars, Tubing, Structurals, etc. Foundry Cutting—standard and reinforced wheels

**Grinding Carbide Tipped Tools**

Write to Abrasive Wheel Department

**Raybestos-Manhattan, Inc.**

MANHATTAN RUBBER DIVISION  
92 TOWNSEND ST. • PASSAIC, N. J.

LIST NO. 1 ON INFO.COUPON PAGE 143

## Notice

This Bulletin Board section of METAL PROGRESS brings you advertisements grouped according to products and services. Each ad carries a reference number at the bottom. Simply list this number on the coupon, page 143, and your requests for literature or other information will receive prompt attention.

**Which is better  
for YOUR product?**



• Request Booklet!

American  
Non-Gran  
Bronze Co.,  
Berwyn,  
Pennsylvania



LIST NO. 3 ON INFO.COUPON PAGE 143

**WANTED**  
**MORE IRON AND  
STEEL SCRAP ...  
OF ALL KINDS!**

Steel mills and foundries need more scrap—all sorts of idle iron—from all types of plants.

Search your plant for this idle metal . . . work with your local scrap dealer to increase supplies of badly-needed iron and steel scrap.

## The Structure of Cast Iron

By Alfred Boyles

U. S. Pipe & Foundry Co.

A book that tells what cast iron really is and gives the facts basic to an understanding of applications.

154 pages . . 94 illus. . . \$3.50

**American Society for Metals**

7301 Euclid

Cleveland

**IMPOSSIBLE**

**NOW POSSIBLE**  
**95-LB. PRECISION  
CASTINGS**



Hastelloy, 316, 347, 410, 431 S.S.  
4130, 4120, 1820, Copper, Aluminum

**AN EXPERIENCED ENGINEERING  
STAFF AVAILABLE TO HELP WITH  
YOUR DESIGN PROBLEMS**

INQUIRIES INVITED . . .  
BROCHURE ON REQUEST

**ALLOY  
PRECISION  
CASTING CO.**

E. 45<sup>TH</sup> ST. & HAMILTON • CLEVELAND, O.

LIST NO. 6 ON INFO.COUPON PAGE 143

# RHODIUM

## Plating

**I**n these days of restrictions on the use of the usual plating metals, the precious metal, rhodium, becomes important as a replacement for them, especially for small articles and parts.

Rhodium is hard and brilliantly white and it cannot tarnish. No acid nor mixture of acids attack it. Our solution has excellent throwing power.

Suggested objects for plating with rhodium are optical mounts, contacts for communication equipment, radar components, surgical instruments and pen and pencil sets. The practical plater's own experience will suggest many others to him.

Commercial rhodium plating was developed in our laboratories. Baker Rhodium Plating Solution is the original and is made under the direction of the men who developed the process.

● Let us send you *Directions for Rhodium Plating*.

**Baker & Co., Inc.**

113 ASTOR STREET  
NEWARK 5, NEW JERSEY

LIST NO. 7 ON INFO-COUPON PAGE 143  
METAL PROGRESS; PAGE 132

## NICKEL CHROME ALLOY DIPPING BASKET



Highest quality baskets  
...strong, safe to handle.  
Mesh can be replaced  
when worn. Long life.  
Standardized for fabri-  
cation to any size. Send  
specifications to Dept. B.

(See our ad on Heat  
Treating Equipment in  
this publication.)

**ROLOCK INC.**  
FAIRFIELD, CONN.

LIST NO. 8 ON INFO-COUPON PAGE 143

## STEAM-JET SPRAY-ETRIC CLEANER

Model  
JC-25

Helps  
1 man  
do the work  
of 5



All-electric steam-detergent cleaning. For plant maintenance and industrial house-keeping. Pressures to 200 p.s.i. Other sizes available. Write for bulletin 74-15.

**Livingstone Engineering Company**  
Manufacturers of Steam Generator  
100 Grove Street • Worcester 5, Mass.

LIST NO. 9 ON INFO-COUPON PAGE 143

SCRAPPY SAYS:

**AID DEFENSE**  
**MORE SCRAP**  
**TODAY...**  
**MORE STEEL**  
**TOMORROW**



**Nonferrous Scrap**  
**Is Needed Too**

## CLEANING EQUIPMENT and MATERIALS

### DEGREASERS

### METAL PARTS WASHERS

### DEGREASING SOLVENTS

TRICHLORETHYLENE  
PERCHLORETHYLENE

### EMULSION and ALKALINE CLEANERS

### RUST-PROOFING and PAINT-BONDING COMPOUNDS

**DETREX**  
CORPORATION  
For All Detroit 32, Michigan

LIST NO. 11 ON INFO-COUPON PAGE 143

## Surface Treatment of Metals

A Symposium by 15 Authors

Includes chapters on anodic treatment of aluminum, passivation and coloring of stainless steel, surface treatment of magnesium, zinc and tin coatings, diffusion coatings, and various mechanical surface treatments.

400 pages . . 140 illus. . . \$5.00

**American Society for Metals**  
7301 Euclid Ave., Cleveland, O.

# Solventol

originators of DI-PHASE metal cleaning



DESIGNERS & BUILDERS OF SPECIALIZED METAL CLEANING EQUIPMENT



SOLVENTOL ORIGINAL PROCESSING, INC.  
DETROIT 2, MICHIGAN

LIST NO. 13 ON INFO-COUPON PAGE 143

## NARACO RACKS

with Replaceable Tips



Manufactured to exacting specifications for:

- ANODIZING
- PLATING
- PAINTING

and Conveyor Purposes.

AMERICAN RACK CO.  
4632 West 21st Place CICERO, ILL.

NATIONAL RACK CO., INC.  
179-181 Madison Street PATERSON, N. J.

IMPERIAL PLATING RACK CO.  
1613 Industrial Avenue FLINT, MICH.

LIST NO. 14 ON INFO-COUPON PAGE 143

## SEAL-PEEL COATINGS



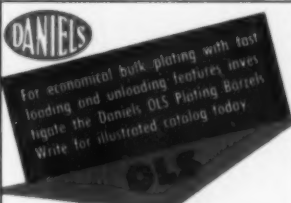


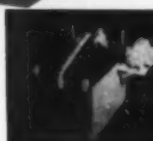
PROTECT METALS AGAINST

RUST  
CORROSION  
SCRATCHES  
ABRASION

Extensive laboratory facilities are at your service for any rust, waterproofing, or corrosion-resistant problem.

*Seal-Peel, Inc.*  
11400 E. 9 MILE ROAD  
VAN DYKE (DETROIT), MICH.

LIST NO. 16 ON INFO-COUPON PAGE 143

## DANIELS PLATING BARREL & SUPPLY CO.

MANUFACTURERS and DISTRIBUTORS  
Electroplating and Polishing  
Equipment and Supplies  
129 Oliver Street • Newark 5, N. J.  
Tel. Market 3-7450

LIST NO. 17 ON INFO-COUPON PAGE 143

# ROUND-THE-CLOCK PRODUCTION!



## Ovens

Batch-Conveyerized.  
Oil-Gas-Steam-Electric Heated.

## Washers

General-Purpose Type.  
In-flight Bar-Gravity-Flushed.  
Oil-Gas-Steam-Electric Heated.

## SPRAY BOOTHS

For manual or automatic spraying.  
All sizes and arrangements.  
New, Up-To-Date and Re-modeling Available.

# peters-dalton Inc.

17932 RYAN ROAD  
DETROIT 12, MICHIGAN

LIST NO. 15 ON INFO-COUPON PAGE 143



## Heating Equipment

### SHERMAN INDUCTION HEATING EQUIPMENT



Megacycle Tube Type Machines

**Soldering • Brazing • Bombarding  
Annealing • Hardening**

Sizes: Standard—2, 4, 10, 25 KVA; Custom—to 100 KVA

**Fast • Powerful • Reliable**

Challenge Comparison—Value • Quality • Price •  
Design • Appearance

Free Trial Run of Your Sample Parts

Complete data, application photos, prices,  
delivery in New illustrated Catalog. Write  
on your company letterhead.

Since 1930...Pioneers in Megacycle Heating



## SHERMAN

Industrial Electronics Company

New York Area Office and Plant

505 Washington Ave., Belleville, N. J.

LIST NO. 18 ON INFO-COUPON PAGE 143

## CIRC-AIR

### HEAT TREATING FURNACES

for  
Every Heat Treating  
Process

★  
**CONTROLLED  
ATMOSPHERES**

★  
**DIRECT FIRED**

★  
**CIRC-AIR DRAW  
FURNACES**

★  
**CIRC-AIR NICARB  
(CARBONITRIDING)**

◀ ○ ▶  
Specially Engineered  
for  
Your Particular Needs

•  
**GAS • OIL • ELECTRIC**

**INDUSTRIAL  
HEATING EQUIPMENT  
COMPANY**

3870 Fremont Pl. • Detroit 7, Mich.

LIST NO. 19 ON INFO-COUPON PAGE 143

METAL PROGRESS; PAGE 134

## Upton

... offers

**THE MOST ADVANCED SALT  
BATH FURNACES FOR . . .**

Batch	Conveyorized
Type	Type
Work	Work

**Upton Electric Furnace Co.**

16000 Hamilton Avenue • Detroit, Michigan

Phone, Diamond 1-2520

LIST NO. 20 ON INFO-COUPON PAGE 143

ALWAYS SPECIFY THE BEST

## Morrison

### ENGINEERED

**FURNACES OVENS**

ANNEALING	CORE BAKING
HARDENING	PAINT BAKING
TEMPERING	ROD BAKING
GALVANIZING	MOLD DRYING
NORMALIZING	LITHOGRAPHING
HEAT TREATING	ANNEALING
DRAWING &	ARMATURE
BRAZING	BAKING

**Morrison ENGINEERING CORP.**

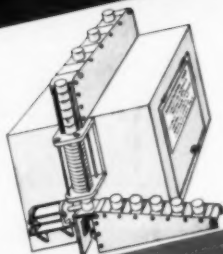
2222 FAIRHILL RD.

CLEVELAND 5, OHIO

LIST NO. 21 ON INFO-COUPON PAGE 143

## MAGNETHERMIC

Low Frequency (60-cycle)  
Induction Heating



the production advantage  
you have been seeking

Approximately every induction plant in the last three years has been equipped with a Magnetothermic 60-cycle billet heater. Now, Magnetothermic furnaces have been adapted for brass, copper, magnesium and steel for annealing, forging, extrusion and other primary and secondary heating, both ferrous and non-ferrous.

- ACCURATELY CONTROLLED HEAT
- UNIFORM HEAT THROUGHOUT PISE
- NO WARM-UP TIME
- OPERATES ON STANDARD POWER SUPPLY
- COOL OPERATION
- AUTOMATIC LOADING AND UNLOADING
- MINIMUM FLOOR SPACE
- SIZES UP TO 20,000 LBS.
- EASY INSTALLATION—CONNECT POWER LEADS AND COOLING WATER. THAT'S ALL.

Prompt Answer to Your Inquiry

WRITE FOR ILLUSTRATED BROCHURE



LIST NO. 22 ON INFO-COUPON PAGE 143

# HEAT RESISTANT CASTINGS

\* **BUFFALO**  
E. A. Mansfield  
Ellicott Square

**CINCINNATI**  
Pearson Browne  
1st Nat'l Bank Bldg.

**CLEVELAND**  
Alloy Sales & Service  
Chas. Plant, Jr.  
8905 Lake Ave., Rm. 303

**DETROIT**  
Gehringer & Forsyth  
16151 James Cousens Hwy.

**HOUSTON**  
B. F. Coombs  
2221 Telephone Rd.

**LONGMEADOW, MASS.**  
B. G. Constantine  
Control Engineering Co.  
51 Converse St.

**MILWAUKEE**  
Ed. P. Lindergren  
3748 W. Greenfield Ave.

**NEW YORK CITY**  
R. B. Steele  
254 W. 31st St.

**PHILADELPHIA**  
Towle & Son  
18 W. Chelton Ave. Bldg.

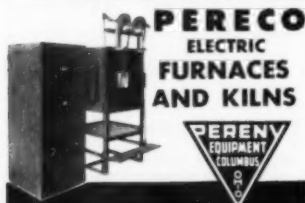
**PITTSBURGH**  
Robt. A. Schmidt  
404 Frick Bldg.

Whenever you have a heating problem that involves heat resistant parts, take advantage of Standard's long experience in producing alloy castings engineered to your specific need. Conveyors, roller hearths, trays, containers, radiant tube assemblies—and many more designs for a wide variety of applications are available.

\* Consult the engineering representative nearest you—or write for the interesting 4-page Bulletin No. 7.

**STANDARD ALLOY CO., INC.**  
1679 COLLAMER ROAD • CLEVELAND 10, OHIO

LIST NO. 23 ON INFO-COUPON PAGE 143



**PERECO**  
ELECTRIC  
FURNACES  
AND KILNS



Clean heat, accurately controlled. Wide choice of models for research, pilot plant, and production. Standard units for temperatures from 450° to 3000° F., or special research equipment up to 5000° F., to meet your needs.

WRITE FOR DETAILS TODAY  
**PERENY Equipment Co.**

Dept. Q, 893 Chambers Rd., Columbus 17, Ohio, U.S.A.  
EXPORT The Inland Export Co., Inc.  
DEPT Green Bldg., New Castle, Pa., U.S.A.

LIST NO. 24 ON INFO-COUPON PAGE 143

## Non-Case

Anti-Carburizing Paint

Applied to any part of steel prior to carburizing, Non-Case protects that specific part from the absorption of carbon. Here is an invaluable coating that prevents carburization, or hardening, of certain spots or sections of steel parts. Easy to use, Non-Case is available in quart or gallon cans.

Write for Descriptive Literature

**THE CASE HARDENING  
SERVICE CO.**

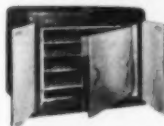
3091 Mayfield Rd., Cleveland 18, O.

LIST NO. 26 ON INFO-COUPON PAGE 143

## PORTABLE ELECTRIC OVENS

FOR THE METAL WORKING INDUSTRY

Standard Models for  
Every Special Need  
**LOW COST**



Model HT-2

Max. Temperature  
1000° F.

Approx. 4 cu.ft.  
working space.

220 Volts — 1 phase. Thermostat controlled. Can be used in groups or banks.

Standard models 225° F and up.

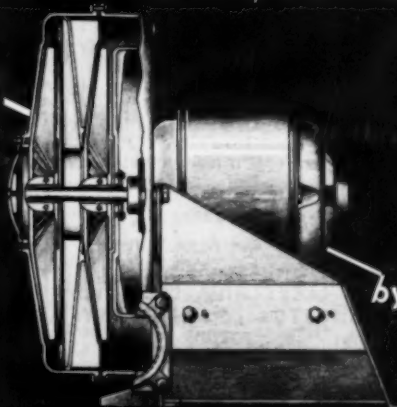
Write for full details.

**GRIEVE-HENDRY CO., INC.**

1646 W. Haddon St. • Chicago 22, Ill.

LIST NO. 27 ON INFO-COUPON PAGE 143

Trouble-Free  
**DESIGN**



Turbo Blowers  
by **North American**  
Manufacturing Company  
GAS OR OIL COMBUSTION EQUIPMENT  
CLEVELAND 5, OHIO

LIST NO. 25 ON INFO-COUPON PAGE 143

## Heat Treating Supplies and Control Equipment

### FOR ALLOY \* CONSERVATION

USE  
**KASENIT**

SURFACE HARDENING  
COMPOUNDS



- NON POISONOUS
- NON EXPLOSIVE
- NON INFLAMMABLE

\* Kasenit saves you money by simply and inexpensively providing controlled surface hardness on plain alloy and carbon steel parts. No scaling or warping. Try KASENIT now.

1-lb. Trial Size ..... \$2.00

**KASENIT  
COMPANY**

799 Greenwich St., DEPT. M  
New York 14, N. Y.  
Established 1912

LIST NO. 28 ON INFO-COUPON PAGE 143

### FREE The Quenzine Story

Low priced, more readily available carbon steels can often replace alloy steels when quenched in Beacon Quenching Oils with QUENZINE added. For information on this new additive and other Beacon Brand Heat Treating Compounds write to ....

**Aldridge  
Industrial Oils, Inc.**

3401 W. 130th St., Cleveland 11, Ohio

LIST NO. 29 ON INFO-COUPON PAGE 143

METAL PROGRESS; PAGE 136

### INSTRUMENTS AND CONTROL FOR HEAT TREATING FURNACES

A complete summary of Hays products applicable to processes such as annealing, brazing and calorizing. Scope includes various methods of firing (underfired, overfired, sidefired), fuel burned (gas, coal, oil), and type of furnace (continuous, rotary hearth, slab heating, etc.).

Hays complete line of draft gages, flow gages, and meters (for high and low pressure gases and liquids), portable gas analyzers and automatic CO<sub>2</sub> recorders are covered.

Send for Bulletin 49-750

**THE HAYS CORPORATION**  
MICHIGAN CITY 20, INDIANA

LIST NO. 30 ON INFO-COUPON PAGE 143

### Control Temperatures More Closely

REDUCE COST • SAVE TIME

This  
Catalog of  
Improved  
Pyrometer  
Supplies  
shows you  
how!



Get your  
FREE Copy  
Today!

- \* Thermocouples • Protection Tubes
- \* Thermocouple Wire • Lead Wire
- \* Insulators • Terminal Heads

**ARKLAY S. RICHARDS CO., Inc.**  
NEWTON HIGHLANDS 31, MASS.

LIST NO. 31 ON INFO-COUPON PAGE 143

### Serving the HEAT TREATING INDUSTRY Since 1930

- Complete Service on Control Equipment
- Thermocouples
- Protection Tubes
- Charts and Lead Wire

**THE CLEVELAND ELECTRIC  
LABORATORIES COMPANY**

1988  
E. 66 St.



Cleveland 3,  
Ohio

LIST NO. 32 ON INFO-COUPON PAGE 143

### 77 Qualified Experts

GIVE THE ANSWER TO

..... *Your*  
**HEAT TREATING  
PROBLEMS**

Here

**Carburizing**—Symposium discussions with thirteen of the country's top authorities.  
330 pages . . . 102 illus. . . . \$4.00

**Controlled Atmospheres**—Sixteen specialists on every phase of this topic in a practical, well illustrated book that belongs in every heat treating department.  
232 pages . . . 84 illus. . . . \$4.00

**Grain Control in Industrial Metallurgy**—

The Library of Congress Quarterly Book List places this volume among the immediately useful works for teachers, students and metallurgists.  
250 pages . . . 109 illus. . . . \$5.00

**Hardenability of Alloy Steels**—By fifteen eminent alloy steel experts who deal with many phases of hardenability in nine comprehensive chapters.  
318 pages . . . 161 illus. . . . \$3.50

**Heat Treatment of Metals**—Ten popular Heat Treating Lectures. Discussions of both furnaces and equipment cover ferrous and nonferrous metals and metal forms.  
178 pages . . . 103 illus. . . . \$3.50

**Induction Heating**—Five leading metallurgists discuss basic problems of heating circuits, distortion, power factors and power efficiency.  
172 pages . . . 113 illus. . . . \$3.00

**Nitriding**—One of the original works on the nitriding process, and still the outstanding source for authoritative information.  
220 pages . . . . . \$3.00

**Principles of Heat Treatment**—M. A. Grossmann, pany, discusses . . . principles . . . Variations . . . heat treating operations.  
244 pages . . . 174 illus. . . . \$4.50

**Order Direct from—  
American Society for Metals**

7301 Euclid Ave.,  
Engineering  
Society

Cleveland 3, Ohio  
of the Metal  
Industry

*Diversified Heat Treating Facilities for . . .*  
**STEEL • ALUMINUM • MAGNESIUM**  
**FORGINGS • CASTINGS • TOOLS AND PARTS**

Carbonitriding  
 Controlled Atmosphere  
 Cyanide and Neutral Baths  
 Liquid, Gas and Pack  
 Carburizing  
 Induction Heating

Pit Type Convection Furnaces  
 Large Car Bottom Furnaces  
 Production Box Furnaces

Solution Heat  
 Treatment  
 Hardening  
 Tempering  
 Normalizing  
 Annealing

Grit Blasting  
 Shot Blasting  
 Shot Peening

Our management, production and sales staff are all metallurgically trained. Their combined experience is available for complete heat treating counsel without obligation.

Send for  
 Free Booklet of  
 Complete Facilities

**Parson** **INDUSTRIAL STEEL TREATING CO.**  
 3737 WEST GARDEN AVE. CHICAGO 38, ILL.

LIST NO. 36 ON INFO COUPON PAGE 143

**42<sup>ND</sup> YEAR** **A VINCENT PROCESS**  
 For  
**EVERY HEAT TREATING NEED**  
 •  
**300-TON DAILY CAPACITY**  
 •  
**MODERN FACILITIES**  
**VINCENT**  
**STEEL PROCESS CO.**  
 3434 Bellevue Ave. • Detroit 7, Mich.

LIST NO. 37 ON INFO COUPON PAGE 143

**HEAT TREAT**  
*at it's Best!*

**COMPLETE SERVICE**  
 including —  
 BRIGHT HARDENING OF STAINLESS STEELS... STEAM TREATING  
 HIGH-SPEED CUTTING TOOLS  
 ... HARDENING ... TEMPERING  
 ... CLEANING.  
 Our Metallurgical Engineers can help with your metal treating problems.

**COMMERCIAL STEEL TREATING CORP.**  
 6100 Tiresman Detroit 4, Mich.  
 TYler 4-6086

LIST NO. 39 ON INFO COUPON PAGE 143

**YOUR COMMERCIAL HEAT TREATER IN DETROIT**

**OFFERS FACILITIES FOR:**

- 1. ALUMINUM** - CAP. 500,000/ PER MO.
- 2. MINUTE PARTS** TO 2-TON DIES
- 3. BRIGHT HARDENING OF STAINLESS STEEL**

**ALL TYPES OF HEAT TREATING CAN BE DONE BY . . .**

**STANDARD STEEL TREATING CO.**  
 3467 LOVETT AVE. DETROIT, MICH.

LIST NO. 40 ON INFO COUPON PAGE 143

**HEAT TREATING**

**Lindberg Steel Treating Company is ideally equipped to serve you in any phase of the heat treating field.**

- Located in four major industrial areas.
- Equipped to perform every process — from the most conventional to the latest and most difficult techniques.
- More than 35 years of experience in processing almost every conceivable type of metal part.
- Trained and experienced metallurgical engineers available for consultation at any time — just call or write.

**3537 E. 16th Street**  
 Los Angeles 23, California

**630 East Taylor Avenue**  
 St. Louis 15, Missouri

**222 N. Lofin Street**  
 Chicago 12, Illinois

**620 Buffalo Road**  
 Rochester 11, New York

**LINDBERG STEEL TREATING CO.**  
 222 N. Lofin Street, Chicago 12, Illinois. Phone: McONroe 4-3108

LIST NO. 38 ON INFO COUPON PAGE 143

## Heat Treating Services

### STEEL TREATING

- FLAME HARDENING
- CARBURIZING & HARDENING
- LIQUID • PACK • GAS
- SHOT BLASTING • ANNEALING
- TENSILE TESTING • NORMALIZING

HEAT TREATING  
& STRAIGHTENING  
OF BARS UP TO  
22' LENGTHS

Established  
1922

MEMBER  
AMERICAN SOCIETY  
FOR  
METALS

HENDERSON 1-3837

### THE W. S. BIDLE CO.

1408 EAST 47TH ST. • CLEVELAND, O.

LIST NO. 41 ON INFO-COUPON PAGE 143

### Heat Treating OF METALS

- |                                      |  |
|--------------------------------------|--|
| Flame Hardening                      | Stress Relieving                         |
| Induction Hardening                  | Normalizing                              |
| Chapmanizing                         | Gas, Pack or Liquid Carburizing          |
| Nitriding                            | Annealing                                |
| Cyaniding                            | Silver-Finish Hardening of Dies or Tools |
| Cadmium, Tin or Copper Plating       | Roto-Blasting                            |
| Anodizing or Alrolocking of Aluminum | Silver or Copper Brazing                 |

#### PITTSBURGH COMMERCIAL HEAT TREATING CO.

90 49th Street

Pittsburgh, Pa.

LIST NO. 42 ON INFO-COUPON PAGE 143

BRIGHT HARDENING and ANNEALING  
of STAINLESS STEEL

HEAT TREATMENT  
of ELECTRICAL ALLOYS

ATMOSPHERE CONTROLLED  
HEAT TREATING

and STANDARD OPERATIONS



**DREVER CO.**

HEAT TREATING DIVISION

224 CAMBRIA ST.

PHILADELPHIA 33, PA.

LIST NO. 44 ON INFO-COUPON PAGE 143

### DON'T WAIT... COOPERATE!



The U.S. Needs Your  
Steel Scrap,  
Now

Nonferrous Scrap  
Is Needed Too

### Boron Steel

Just off the press . . .

a timely collection of  
eight articles on boron  
steel, reprinted from  
METAL PROGRESS.

Write now for your copy  
of this new publication.  
Price is \$1.00.

American Society  
for Metals

7301 Euclid

Cleveland



LIST NO. 43 ON INFO-COUPON PAGE 143

METAL PROGRESS; PAGE 138

### Scientific STEEL IMPROVEMENT



BIG AS THEY COME

OR BY THE HANDFUL

THE *Lakeside Steel Improvement Co.*

3418 LAKESIDE AVE., CLEVELAND 14, OHIO HENDERSON 1-9100



*Our Services:* Electronic Induction Hardening, Flame Hardening, Heat Treating, Bar Stock Treating and Straightening (mill lengths and sizes), Annealing, Stress Relieving, Normalizing, Pack, Gas, or Liquid Carburizing, Nitriding, Speed Nitriding, Aerocasing, Chapmanizing, Cyaniding, Dry Cyaniding, Sand Blasting, Tensile and Bend Tests.



**COMPLETE  
METALS TESTING  
SERVICE**

- CHEMICAL
- RADIOGRAPHIC
- PHYSICAL
- METALLOGRAPHIC
- ★ SPECIAL STUDIES WITH RADIOACTIVE TRACERS

• **UNITED STATES TESTING COMPANY, INC.**

ESTABLISHED 1888

3415 PARK AVENUE HOBOKEN, N. J.

NEW YORK • BOSTON • PHILADELPHIA • MEMPHIS • DALLAS  
HOBOKEN • PROVIDENCE • CHICAGO • LOS ANGELES • DENVER

LIST NO. 47 ON INFO.COUPON PAGE 143

**MERIAM**  
**MANOMETERS**

U-TYPE • WELL TYPE • DUAL TUBE

**FLOW METERS  
DRAFT GAUGES**

For measuring pressure, vacuum and differential pressure of liquids and gases. Also a complete line of accessories.

ASK FOR CATALOG C-12

**THE MERIAM INSTRUMENT CO.**  
10932 MADISON AVE.  
CLEVELAND 2, OHIO

◀ U-TYPE MANOMETER

LIST NO. 48 ON INFO.COUPON PAGE 143

*Headquarters for*  
**NON-DESTRUCTIVE TESTING  
and  
MEASURING INSTRUMENTS**

\* \* \*

**ULTRASONIC & MAGNETIC  
INSPECTION EQUIPMENT**

Clack & Defect Locators  
Metal Sorters  
Ultrasonic Thickness Gages

**ELECTRONIC MICROMETERS**  
For production measurement of precision components to within 0.000020 in.

**J. W. DICE CO.**  
INGLEWOOD, N. J.

SEND FOR BULLETIN 21

LIST NO. 50 ON INFO.COUPON PAGE 143

## Solve INSPECTION DEMAGNETIZING SORTING PROBLEMS *with* MAGNETIC ANALYSIS EQUIPMENT

Electronic Equipment for non-destructive production inspection of steel bars and tubing for mechanical faults, variations in composition and physical properties. Average inspection speed 120 ft. per minute.

*This Equipment is now employed by more than 40 Steel Mills and many Steel Fabricators.*

### MAGNETIC ANALYSIS DEMAGNETIZERS

Electrical Equipment for efficient production demagnetizing of steel bars and tubing. When used with Magnetic Analysis Equipment inspection and demagnetizing can be done in a single operation.

### MAGNETIC ANALYSIS COMPARATORS

Electronic Instruments for production sorting of ferrous and non-ferrous materials and parts for variations in composition and physical properties.

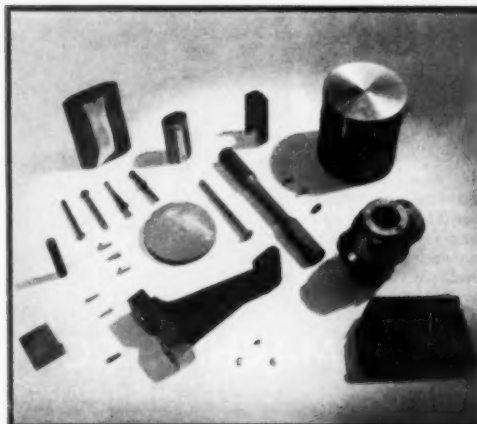
### ALSO MAGNETISM DETECTORS

Inexpensive pocket meters for indicating magnetism in ferrous materials and parts.

"THE TEST TELLS"

For information write  
**MAGNETIC ANALYSIS CORP.**  
42-44 Twelfth St. Long Island City 1, N. Y.

LIST NO. 51 ON INFO.COUPON PAGE 143



IF CONTROL OF THESE PARTS  
IS YOUR PROBLEM . . .  
**SPECTROSCOPY IS THE  
ANSWER!**

Undivided responsibility for complete installation of  
all Spectrographic equipment.

**NATIONAL SPECTROGRAPHIC  
LABORATORIES, INC.**

6300 EUCLID AVENUE

CLEVELAND 3, OHIO

LIST NO. 49 ON INFO.COUPON PAGE 143

# FLASH-O-LENS Lights and Magnifies METAL SURFACES FOR FAST, ACCURATE INSPECTION



LIST NO. 52 ON INFO-COUPON PAGE 143

Another FLASH-O-LENS at work—this time at Eastman Kodak Company!

You too can cut down inspection time and improve product quality by using this simple, handy, low-cost instrument that spotlights the work and magnifies it at the same time . . . the FLASH-O-LENS!

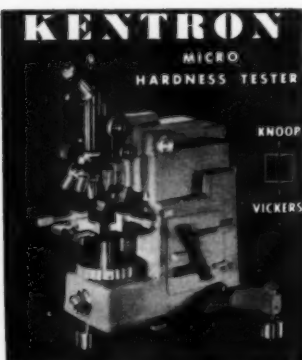
Just put a FLASH-O-LENS on the part you're inspecting. Built-in bulb puts light on the field of vision—keeps it out of user's eyes. Accurately ground lenses give sharply detailed enlargement. Result: time-and-eye-saving inspection, surer maintenance of quality standards.

Battery-operated and plug-in models—\$10.65 up. Write for literature on suggested applications, types and prices.

## E.W. PIKE & COMPANY

492 NORTH AVE.

ELIZABETH, N. J.



Applies 1 to 10,000 gram loads

Write for Bulletin

**KENT CLIFF LABORATORIES**  
PEERSKILL NEW YORK

LIST NO. 53 ON INFO-COUPON PAGE 143

## LABORATORY FURNACES



You tell Boder what you need.

Boder Scientific Co.  
719-723 Liberty Ave.  
Pittsburgh 22, Pa.



LIST NO. 55 ON INFO-COUPON PAGE 143

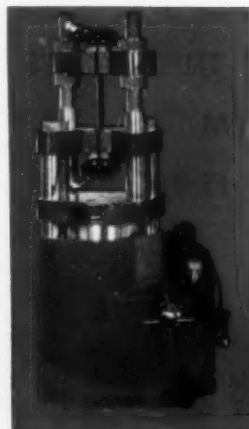


### for Fast and Efficient HARDNESS TESTING

Works on the principle of forcing a hardened, spring-loaded steel point into the surface, the amount of penetration registering instantly on a dial indicator to give a dependable measure of hardness. Operator simply places Impressor on surface and presses down firmly. Can be used in any position, even against edges or ends of pieces when stacked. Requires little effort, ideal for women inspectors. Strongly built for durability and consistent accuracy. Thousands in use. Comes in self-lined, fitted wood case with extra point and full maintenance instructions. Write for Bulletin F-1689-1.

**BARBER-COLMAN COMPANY**  
1225 ROCK STREET • ROCKFORD, ILLINOIS

LIST NO. 56 ON INFO-COUPON PAGE 143



## FAST ACTION IN TENSILE AND BRINELL TESTING

Whether your testing problems involve the tensile strength or Brinell hardness of metals or component parts, Detroit Testing equipment will speed your operations. In fact, on any tests involving metals, consult Detroit Testing—or write for informative literature.



## DETROIT TESTING MACHINE CO.

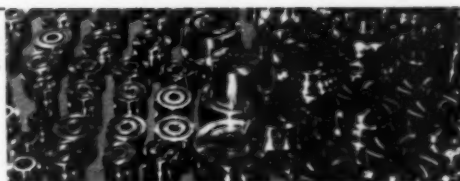
9390 GRINNELL AVENUE

DETROIT 13, MICHIGAN

LIST NO. 54 ON INFO-COUPON PAGE 143

METAL PROGRESS; PAGE 140

## ARDCOR TUBING ROLLS



### \*PRODUCTION PROVEN — 30% More Footage!

These Tubing Rolls, made of ARDCORLOY\*—a special alloy steel, were designed and manufactured by ARDCOR for one of America's leading Welded Tube Manufacturers (name on request).

What are YOUR Roll Forming Requirements?

ARDCOR ROLLER DIES • ROLL FORMING MACHINERY • CUT-OFF MACHINES

**American ROLLER DIE CORPORATION**  
20680 St. Clair Avenue Cleveland 17, Ohio

LIST NO. 57 ON INFO-COUPON PAGE 143

## STEEL DOMESTIC AND IMPORTED

SPECIALIZING IN

- TOOL STEEL
- ALLOY STEEL
- CARBON STEEL
- STRUCTURAL STEEL

PHONE OR SEND INQUIRIES

**AMERICAN ENTERPRISE CO.**  
156 E. 52ND ST., N. Y. 22, N. Y.  
PHONE: PLAZA 8-1153

LIST NO. 58 ON INFO-COUPON PAGE 143

## Darwin

**PRK-33** ◀ Air Hardening  
Non Deforming  
13% Cr, 3% Co

**NEOR** ◀ Oil Hardening  
Non Deforming  
13% Cr, 2% C

**MINEOR** ◀ Air Hardening  
Non Deforming  
5% Cr, 1% Mo

**DARWIN & MILNER INC.**

Highest Grade Tool Steels

2345 St. Clair Avenue  
Cleveland 14, Ohio

LIST NO. 60 ON INFO-COUPON PAGE 143

## TOOL STEEL

NATIONALLY KNOWN  
BRANDS

### BELOW MILL PRICES

- High Speed:  
T-1 to T-15, M-1 to M-56
- High Carbon—High Chrome
- Oil Hardening
- Air Hardening
- Water Hardening
- Hot and Cold Work-Die Steel
- Fast Finishing Steels

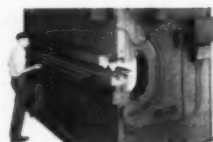
COMPLETE WAREHOUSE  
FACILITIES

MILL GUARANTEED

## RELIABLE STEEL CO.

78-82 Lockwood Ave.  
Riverside 8, N. J.

LIST NO. 61 ON INFO-COUPON PAGE 143



Corrugating and any  
straight-line production  
bending can be done to  
hairline accuracy.



Conical sections are quickly  
formed with standard  
bending dies by use of the  
ram-tapering mechanism.



Large holes can be  
punched singly. Smaller  
holes can be punched 25  
to 150 at a time.

Steelweld Presses for  
bending, forming, blank-  
ing, drawing and multi-  
ple-punching opera-  
tions. Complete line for  
all size metal to 1 1/4" x  
20'-0". Write for free  
copy of catalog No.  
2010.



Steelwelds have heavy duty one-piece  
welded frames that stay rigid for life.  
Machinery is top quality throughout and  
easy to maintain.

**THE CLEVELAND CRANE & ENGINEERING CO.**

5941 East 281st Street Wickliffe, Ohio

LIST NO. 59 ON INFO-COUPON PAGE 143

**C. A. DAHLIN meets every Engineering Problem**

**METAL Spinning**  
the intricate to the Industrial


**Stamping**  
to Engineer's Specifications

**Fabricating**  
Complete Facilities

IF it's intricate or simple...large or small production...  
...any metal you name - Investigate the C. A. Dahlin  
facilities for dependable service and quality workmanship.

Write today for the C. A. Dahlin Special Bulletin.

**C. A. DAHLIN COMPANY**  
2729 CLYBOURN AVENUE • CHICAGO 14, ILLINOIS  
Phone LAkeview 5-9116



LIST NO. 62 ON INFO-COUPON PAGE 143

USE OUR

**HOEGANAES**

**SPONGE IRON POWDER**

for

*Powder Metallurgy  
Fabrication  
and other  
Metallurgical Purposes*

**EKSTRAND & THOLAND, Inc.**  
441 Lexington Avenue  
New York 17, N. Y.

LIST NO. 63 ON INFO-COUPON PAGE 143

**CONSERVE METALS...**  
with 3 DIMENSIONAL  
**Rigidized**  
*Aluminum* **Metals**

You'll get:

- REDUCED WEIGHT
- ADDED STRENGTH
- IMPACT RESISTANCE
- SURFACE PROTECTION
- REDUCED MAINTENANCE COSTS
- MORE SQUARE FEET PER POUND OF METAL


WRITE FOR FREE CONSERVATION  
HANDBOOK

**Rigidized Metals Corporation**  
482 OHIO STREET, BUFFALO 3, N. Y.  
Offices in Principal Cities in U.S.A. & Canada

LIST NO. 64 ON INFO-COUPON PAGE 143

METAL PROGRESS; PAGE 142

**For Stainless Steels, Spring  
Steels, Cold Finished Steels,  
Drill Rods, Cold Rolled  
Strip, Cold Rolled Sheets,  
Aluminum Sheets and Bars**



Stainless Steel in strip, sheet, bars, tubing and accessories.

**Cold Finished Steels** in all standard shapes and carbon analyses.

**Spring Steels** in Blue Tempered and Polished Coils, Cold Rolled Annealed Coils and Straight Lengths in 1070 and 1095 Carbon grades and Hot Rolled SAE 1095 and 9255 Bars. Wires include Polished Music Spring Wire, Black Oil Tempered Spring Wire.

**Cold Rolled Sheets** - Cold Rolled Strip in coils and straight lengths, all tempers, slit, sheared and round edge.

**Planet Drill Rods** Rounds sizes from .013 to 2 in. - flats and squares.

**Aluminum Sheets** in coils and straight lengths in all alloys. - Aluminum Bars and Rods.

**A. R. Parry Co.**  
INC.  
Page Ave., Lyndhurst, New Jersey

STANDARD 5-0100 CONSTRUCTION 5-0100  
STANDARD 5-0100 CONSTRUCTION 5-0100  
NEW YORK CITY 5-0100 CONSTRUCTION 5-0100

**A. R. Parry Co.**  
INC.  
Page Ave., Lyndhurst, New Jersey

STANDARD 5-0100 CONSTRUCTION 5-0100  
STANDARD 5-0100 CONSTRUCTION 5-0100  
NEW YORK CITY 5-0100 CONSTRUCTION 5-0100

LIST NO. 65 ON INFO-COUPON PAGE 143

**"SILVERCOTE"®**

**BERYLLIUM  
COPPER**

*Hardenable & Tempered*

ALSO OTHER NON-FERROUS  
**WIRES**  
for

- ★ SPRINGS
- ★ FORMS
- ★ SPECIAL PURPOSES

**LITTLE FALLS ALLOYS  
INCORPORATED**  
189 Caldwell Ave. • Paterson 1, N. J.

LIST NO. 66 ON INFO-COUPON PAGE 143

**WHITELIGHT  
MAGNESIUM**

your comprehensive independent  
source of magnesium alloy

Tubes • Rods • Shapes • Bars  
Hollow Extrusions • Plate • Strip  
• Pipe • Wire • Welded and  
Riveted structures and assemblies

**WHITELIGHT  
MAGNESIUM**

**WHITE METAL ROLLING  
& STAMPING CORP.**  
82 Moultrie St., Brooklyn 22, N. Y.  
Sales Office  
376 Lafayette St., New York 3, N. Y.

LIST NO. 67 ON INFO-COUPON PAGE 143

# LEAKE

*Creative*

## METAL STAMPINGS

Any Size-Shape-Thickness-Analysis

Literature on request

**THE LEAKE STAMPING CO.**  
MONROE, MICHIGAN

LIST NO. 68 ON INFO COUPON BELOW



### WAGNER ELECTRODE HOLDERS

#### WELD BETTER WITH

- \* WAGNER  
GROUND CLAMPS
- \* WAGNER  
CABLE CONNECTORS
- \* WAGNER  
"SWEDG-ON" ITEMS

Sold Only Thru  
Welding Supply  
Houses

**WAGNER  
MFG. CO.**

350 W. 1st SOUTH ST.  
JACKSON, MISSOURI

LIST NO. 69 ON INFO COUPON BELOW



### WELDER'S CRAYON

KORN'S welder's crayon

Korn's special crayons, developed specifically for welding operators, layout men and other metal workers, will produce permanent markings on all types of hot, cold, wet or dry metals. Mark your cutting and welding lines for easier and more accurate results.

**Wm. KORN, INC.**

860 WEST ST. • DEPT. M. P.  
NEW YORK 13, NEW YORK

LIST NO. 70 ON INFO COUPON BELOW

### A CABLE SPLICED IN 10 SECONDS!



**ERICO PRODUCTS, INC.**

Complete Arc Welding Accessories

2976 E. 61st Place, Cleveland 3, Ohio

Write for Caddy Catalog

LIST NO. 71 ON INFO COUPON BELOW

**MAURATH, INC.**

★ MANUFACTURERS AND PROCESSORS OF STAINLESS AND HEAT RESISTANT  
ARC WELDING ELECTRODES

★ ALL ANALYSES—COATED, STRAIGHTENED AND CUT, OR COILED FOR  
AUTOMATIC WELDING

**MAURATH, INC.**

NORTH RANDALL (CLEVELAND 23), OHIO

Telephone: MOntrose 2-4100

21830 MILES AVENUE



LIST NO. 72 ON INFO COUPON AT LEFT

### READERS' INFO-COUPON SERVICE, METAL PROGRESS

7301 Euclid Avenue, Cleveland 3, Ohio

Please send further information, as checked at the right, on the advertisements in the Bulletin Board with numbers I have listed below—

(Please check)

	Send Catalog or Engineer- ing Data	Send Price Info	Nearest Source of Supply
(Bulletin Board Item Number) _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Your Name \_\_\_\_\_ Title \_\_\_\_\_

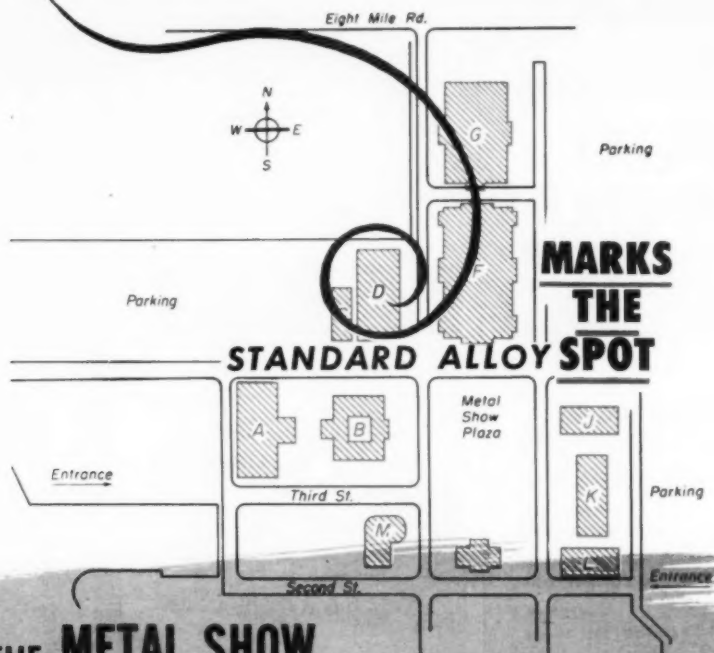
Company \_\_\_\_\_

Street \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_



# BUILDING "D" - BOOTH D-140



AT THE METAL SHOW...

CHARLEY **GEHRINGER** AND RAY **FORSYTH**  
JOIN  
**HARVEY SMITH**

... for a triple-play welcome and reception at Standard Alloy's centrally-located exhibit. Many heat resistant castings will be displayed. Engineered applications that will help solve your heat treating problems will be shown.

... let us help to make your visit informative, helpful and long-remembered. See Standard at the Metal Show—or call any of the representatives below—for service.

## STANDARD ALLOY CO.

1679 COLLAMER ROAD • CLEVELAND 10, OHIO

**BUFFALO**  
E. A. Mansfield  
Ellicott Square

**CINCINNATI**  
Pearson Browne  
1st Nat'l Bank Bldg.

**CLEVELAND**  
Alloy Sales & Service  
Chas. Plant, Jr.  
8905 Lake Ave., Rm. 303

**DETROIT**  
Gehring & Forsyth  
16151 James Cousens Hwy.

**HOUSTON**  
B. F. Combs  
2221 Telephone Rd.

**LONGMEADOW, MASS.**  
B. G. Constantine  
Control Engineering Co.  
51 Converse St.

**MILWAUKEE**  
Ed. P. Lindergrun  
3748 W. Greenfield Ave.

**NEW YORK CITY**  
R. B. Steele  
254 W. 31st St.

**PHILADELPHIA**  
Towle & Son  
18 W. Chelton Ave. Bldg.

**PITTSBURGH**  
Robt. A. Schmidt  
404 Frick Bldg.

# Tool Steel Topics



## Fresh-roasted Chisels Halt Costly Breakage

A foundry in the Middle West had long depended on a rule-of-thumb heat-treater to harden the large number of chisels they used daily. One day he quit abruptly. No great concern was felt about his departure—until they began to break as many as 300 chisels in one day.

A trouble-shooter, hurriedly summoned, soon traced the appalling breakage to the as-quenched brittleness of the chisels. The departed heat-treater hadn't revealed how he relieved this condition.

The trouble-shooter went on to explain that the chisels had to be tempered after hardening. But there was no suitable heat-treating equipment in the foundry. Suddenly he hit on the answer. "Tell you what—you can get one of those electric turkey roasters. They cost only about twenty-five bucks and they'll give you a tempering range of about 250 to 500 F. Just what you need."

The division foreman was dubious. How could roasting the chisels do any good? But he bought a roaster and put it on the job. To his surprise it cured the breakage. In the first week they averaged only one broken chisel a day. The roaster paid for itself in no time.

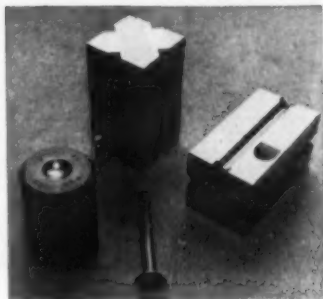
Many tools and dies fail because they haven't been tempered after hardening. Not holding tools at the tempering temperature long enough causes the same sort of trouble. Another important point: always temper tools before they cool down to room temperature. Usually it's best not to let them cool below 150 F.

## Cold-heading Die Steel Takes a Real Beating

Maybe you've seen a cold-heading machine in action, forging bolts, rivets, screws, and other products at high speed. The tools and dies which do the cutting, gripping, and heading have to be seen at work to be appreciated. Minute after minute, day after day, they withstand continuous terrible pounding.

Good cold-heading die steel—used for the solid, open, and header types of dies—must have a hard, long-wearing surface, reinforced by a tough core. The hard, wear-resisting case must be deep enough to prevent sinking or upsetting and tough enough to absorb heavy pounding without chipping or spalling.

Cold-heading die steel is one of our special-purpose tool steels. It took quite a few years to work out the right carbon content, depth of hardness, and grain size. For example, we've found that a shallow-hardening steel is best for header dies up to 2-in. diameter; for larger dies a deep-hardening steel gives longer service. Both are fine-grained tool steels, made ever so carefully to insure the ulti-



*These gripper and header dies of Bethlehem Cold-Heading Die Steel have the ideal combination of hard surface and tough core for cold-heading thousands of bolts each day.*

mate in cleanliness and freedom from injurious defects.

We call it Bethlehem XX Cold-Heading Die Steel. It's really tops for this kind of punishing service. Like to know more about it? Address your request to our Publications Department, Bethlehem, Pa. Ask for Booklet 261.



### Our Tool Steel Engineer Says:

**A modified oil-quench gets rid of scale on air-hardening tool steels**

Some toolmakers object to air-hardening steels because a thin, adherent scale may form during the air-quench. Avoiding this scale is really easy.

Quench the tool or die in oil until it just loses color . . . 900 to 1000 F . . . then cool it in air to about 150 F, followed by the usual tempering operation. The oil-quench will "throw" the scale. But the tool won't crack, because air-hardening

steels do not begin to transform, or harden, until they reach 400 F or less.

However, air-hardening steels must not be quenched in oil long enough to cool them down below the temperature at which transformation takes place. If this precaution is ignored, cracking of the tool is likely to result.

Air-quenching, of course, results in the minimum amount of distortion.

**Bethlehem**



**Tool Steel**

See demonstration  
Booth No. G121—Bldg. G.  
National Metal Exposition

IN **2** MINUTES...  
metal analyses  
in multiple copies

Only ARL Production Control  
Quantometer\* gives you direct  
reading, pen-and-ink records of

quantitative spectrochemical analyses with extra copies, as desired.

Would quick, accurate chemical analyses of metals or other inorganic materials, available in a matter of minutes in the form of multiple-copy graphic records, help solve your testing and production problems?

If so, the Production Control Quantometer, pioneered and perfected by our engineering staff, deserves your most serious consideration. Unique in its field, this instrument is in daily use throughout the country, helping to speed production of critical materials, improving laboratory controls, and assisting scientific research.

Representing the most advanced type of spectrometer yet developed, and manufactured by the world's largest manufacturer of this kind of equipment, it is extremely efficient, versatile and applicable to a wide variety of needs. As many as 25 chemical elements as selected by the user can be measured on the Production Control Quantometer—up to 20 simultaneously. Individual units are not limited to a single type of analysis, but can be designed to meet the requirements of many major plant problems. Results are comparable to chemical analyses in accuracy.

*The complete ARL line also includes 1.5 and 2-meter  
Spectrographs, Source Units and related accessories.*



Write for this  
informational  
brochure

\*Trademark



**Applied Research Laboratories**  
SPECTROCHEMICAL EQUIPMENT

4336 SAN FERNANDO ROAD • GLENDALE 4, CALIFORNIA  
NEW YORK • PITTSBURGH • DETROIT • CHICAGO • LOS ANGELES

# A 2-WAY OFFER

to those who have not yet fully  
investigated the amazing

## SALT BATH HEAT TREATMENT PROGRESS OF THE PAST 5 YEARS

- 1** Write today on your company letterhead for a free copy of the 72-page Ajax data booklet "Electric Salt Bath Furnaces." Here you will find the complete, fully-authenticated story of exactly how and why these famous furnaces surpass any other type of heat treating equipment in quality, speed, and economy, in *4 cases out of 5*. And you will also find a wealth of heat-treating data that may go far toward putting this phase of your production on a sounder basis.

- 2** Choose your furnaces on the basis of actual proof, not on mere claims. Send—or bring—a specimen batch of your work for treatment in the full-commercial scale Ajax Metallurgical Service Laboratory. Learn exactly what you can expect from this method in specific terms of improved physical properties, faster production, less floor space, lower labor costs, reduced maintenance and greater efficiency all along the line. There is not the slightest cost or obligation on your part. Write or wire today.

### AJAX ELECTRIC COMPANY, INC.

910 Frankford Ave.

Philadelphia 23, Pa.

The World's Largest Manufacturer of Electric Heat Treating Furnaces Exclusively

#### AFFILIATED COMPANIES:

Ajax Electro Metallurgical Corp.; Ajax Electric Furnace Corp.; Ajax Engineering Corp.; and Ajax Electrothermic Corp. (IN CANADA: Canadian General Electric Co. Ltd., Toronto, Ont.)

See Us At The Metal Show—Booth F-421



**AJAX**  
HULTGREN

**ELECTRIC SALT BATH FURNACES**

More Dependable . . . More Economical  
On 4 Applications out of 5



### AJAX OFFERS

ABSOLUTE QUALITY CONTROL

FASTER PRODUCTION IN LESS SPACE  
WITH UNSKILLED LABOR

MAXIMUM EFFICIENCY AND ECONOMY  
IN EVERY STEP OF THE WORK

for: Carburizing • Cyanide Hardening  
Neutral Hardening • Hardening High Speed Steel  
Annealing or Hardening Stainless Steel • Brazing  
Austempering • Martempering • Process Annealing  
Cyclic Annealing • Solution Heat Treatment  
Tempering • Descaling • Cleaning • Desanding

# "DIVERSITY"

ERIE builds the right hammer for the job . . . Here illustrated in operation are Erie Steam, Air, Board Drop and Pneumatic Hammers, Erie Single and Double Frame Forging Hammers, and Erie Trimming Presses . . . products of a half century of hammer design and building "know how". Erie engineers will consult with you on your requirements . . . write us before purchasing equipment for producing modern forgings.



All parts on Erie Hammers subject to impact, upper works, frames and anvil are steel.



Bulletins giving full details on any or all of these Erie products are available to you for the asking.

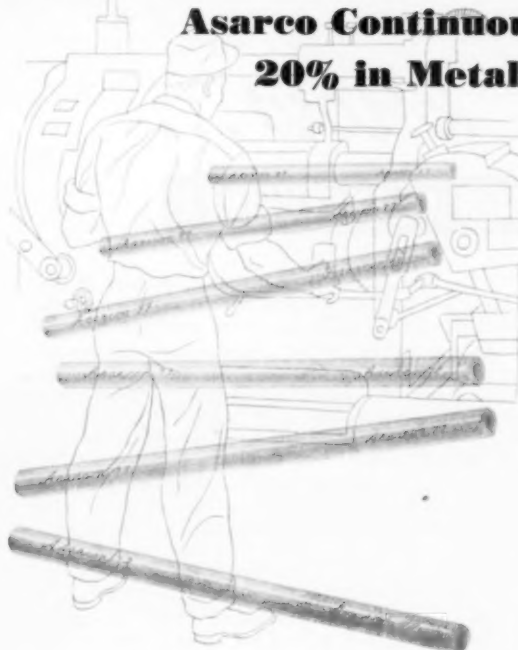
ERIE FOUNDRY COMPANY, ERIE, PA.

**ERIE BUILDS Dependable HAMMERS**



## Customer Reports:

# Asarco Continuous Cast Bronze Saves 20% in Metal Cost, Production Time



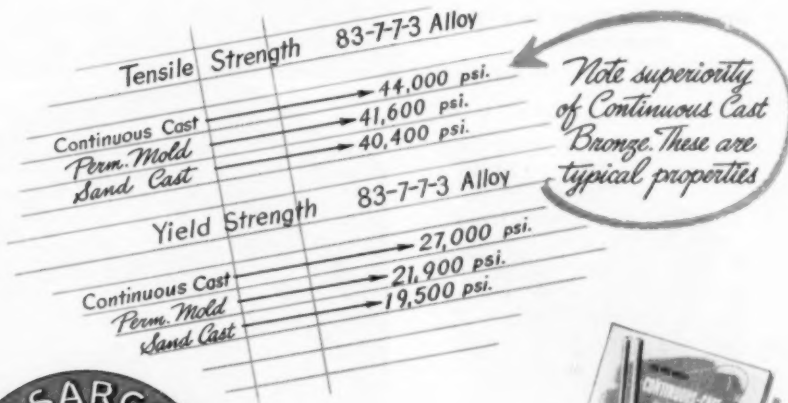
A manufacturer of packaging machinery tells of saving 20% in production time and 20% in material cost when he makes shaft bearings and nuts of Asarco Continuous Cast Bronze.

The patented Asarco casting process guarantees him bronze rod that is free from the hard and soft spots so often found in sand cast bronzes. Stock is exceptionally uniform and free from porosity. Since sand is not used, and dirt and dross are excluded, there can be no surface or internally trapped abrasive to dull tools or discourage high cutting speeds. Rejects are virtually unknown.

Dimensions are held to extremely close limits. For example, tube concentricities are within 1.5% of wall thickness. Dimensional uniformity is assured . . . machining on automatics is standard practice.

Continuous Cast Bronzes can be made to order in a wide variety of alloys . . . in standard lengths of 12' . . . lengths 5' to 12' on request . . . lengths 12' to 20' on special arrangement.

216 sizes of standard Asarco 773 bronze (SAE 660) are stocked in 105' lengths for convenience at warehouses in all principal cities. Distributors will cut this stock long or short to suit your needs.



Send for this free catalog on Asarco Continuous Cast Bronzes. It contains physical properties, table of weights, photomicrographs, table of stock shapes and sizes and other data.



West Coast Sales Agent:  
KINGWELL BROS. LTD., 444 Natoma Street, San Francisco, Calif.

**American Smelting and Refining Company**

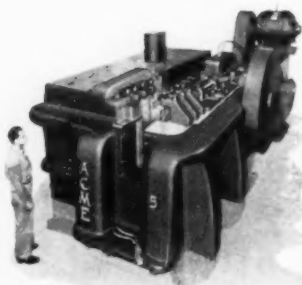
OFFICES: Perth Amboy Plant, Barber, New Jersey  
Whiting, Indiana

# Do you know...

## ACME'S XN TOGGLE DESIGN IS EXCLUSIVE?



Double Toggle Cluster for 2" and larger machines.

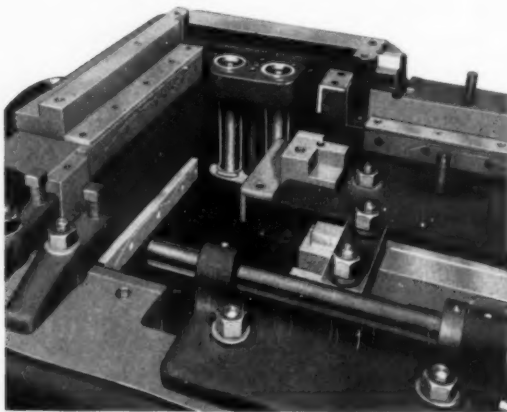


● Among the outstanding features of the Acme XN Forging Machine, none is more important than the Acme Toggle design and construction.

This solid Toggle link construction, exclusive to Acme XN Forging Machines, has large continuous surface areas which reduce pressures per square inch, reflecting lower maintenance cost. Acme design eliminates shoulder wear on pins and bushings common to the hinged or laced type toggles.

The Toggle Links rigidly support the gripping die with a continuous bearing throughout the entire length and height, insuring uniform gripping in all parts of dies and resisting any tendency for the forging dies to breathe—the common cause of excessive flash, swollen and eccentric forgings.

The powerful action of the Acme Toggle Mechanism permits numerous operations, such as squeezing, piercing, shearing, as well as actual forging operations to be performed between the forging dies.

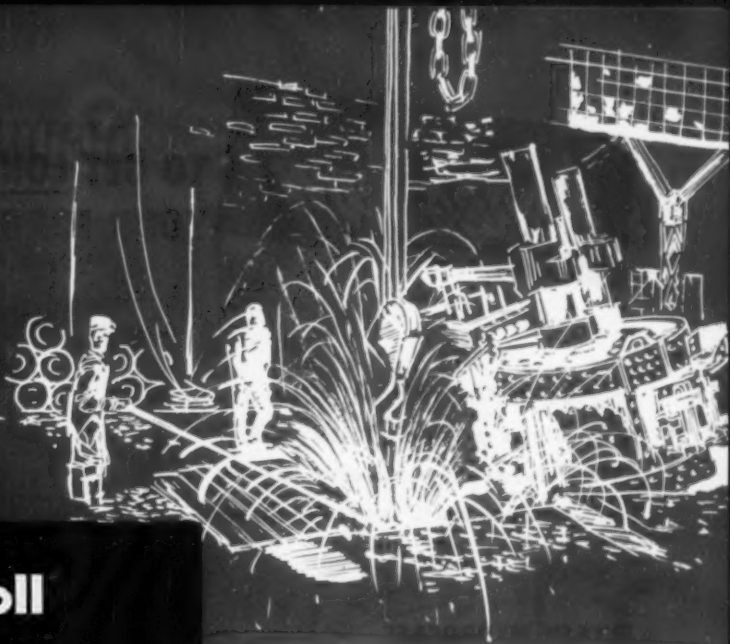


Die Slide Pocket for Double Toggle 2" and larger machines.

## THE HILL ACME COMPANY

ACME MACHINERY DIVISION • 1207 W. 65th St., Cleveland 2, Ohio  
ESTABLISHED 1882

"ACME" FORGING • THREADING • TAPPING MACHINES • ALSO MANUFACTURERS OF "HILL" GRINDING AND POLISHING MACHINES  
HYDRAULIC SURFACE GRINDERS • "CANTON" ALLIGATOR SHEARS • PORTABLE FLOOR CRANES • "CLEVELAND" KNIVES • SHEAR BLADES



make **Ingersoll**  
your prime source of supply  
for **SPECIAL STEELS**

Alloy Steels  
Armor Plate  
Clutch Plate Steels  
Tillage Steels  
Soft Center Steel  
Shovel Steels  
Knife Steels  
Saw Steels, including  
High Speed Hack Saw Blade Steels  
TEM-CROSS Steel  
Stainless Steels  
INGACLAD Stainless-Clad Steel

**Ingersoll** STEEL DIVISION

**BORG-WARNER**  
New Castle,



**CORPORATION**  
Indiana

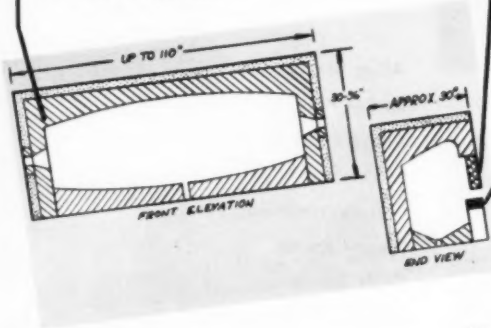
# here's how

## TO GET LONGER LIFE FOR YOUR FORGE FURNACE LININGS

**Taylor Sillimanite (TASIL) refractories prolong service life of 50 furnaces operated by an automotive parts manufacturer.**









● **TASIL HYDROCAST**—the hydraulic-setting castable refractory for service up to 3000° F.—is used to cast the backwall, end walls, burner openings and roof. Mix Hydrocast with water and pour in place like concrete—your special shapes are in the bag! TASIL Hydrocast main linings in these furnaces are giving a minimum of one year's service.



● **TASIL TILE** are used for the front arch, where resistance to spalling from thermal shock or rapid heating is required. TASIL tile generally last from 2 to 6 months, depending on the severity of the furnace operation. This is 4 to 6 times the life of fireclay tile.

● **TAYCOR BRICK** (90%  $Al_2O_3$ ) were selected to form the bottom of the slot because of their excellent resistance to abrasion and attack from iron scale. Fire brick in this location had to be replaced weekly—TAYCOR brick average three months. Very little scale or slag stick to the TAYCOR brick and that which does cleans off easily.

CROSS SECTIONAL VIEWS OF FORGING FURNACE

	RAMMED CHROME ORE
	TASIL HYDROCAST #402
	TAYCOR BRICK
	TASIL TILE
	FIREBRICK OR INSULATING BRICK
	FIREBRICK

If your heavy-duty or high-speed heating and heat-treating furnaces still require too-frequent shutdowns for re-lining, investigate the advantages of Taylor Sillimanite. Write direct, or contact the Taylor Representative in your area, for recommendations on your furnace problem. No obligation, of course.

Exclusive Agents in Canada:  
REFRATORIES ENGINEERING AND SUPPLIES, LTD.  
Hamilton and Montreal

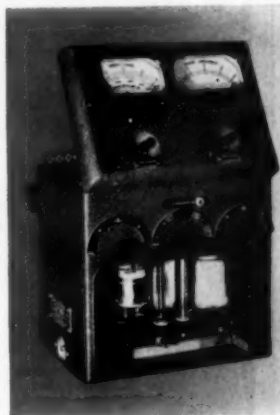


Refractors to industry since 1864.

### The CHAS. TAYLOR SONS Co.

MANUFACTURERS OF REFRACTORIES • CINCINNATI • OHIO • U.S.A.

Not an instrument  
you  
buy...  
but a  
service  
we  
supply



Now *within seconds* you can get an accurate and complete picture of combustion conditions in your furnaces. A Cities Service Combustion Engineer, by applying his *exclusive* Heat Prover, will quickly secure continuous, accurate readings that reveal any oxygen excess or waste combustibles present.

Operators throughout the country, by using these instant readings as their guide, have been improving furnace output and product quality, while saving fuel.

Similar results are possible at your plant. Start the ball rolling today for a **FREE** Heat Prover test of your furnaces. Simply call or write your local Cities Service office . . . or else return the coupon below.



**THE COMPLETE CITIES SERVICE LINE FOR THE METAL FABRICATING INDUSTRY INCLUDES**

Chillo Cutting Oils      Trojan Greases  
Trojan Gear Oils      Optimus Cylinder Oils  
Pacemaker T Hydraulic Oils  
Q-T (Quenching and Tempering) Oils



CITIES SERVICE OIL CO.  
Sixty Wall Tower, Room 153  
New York 5, N. Y.

Without obligation please send your booklet,  
"Combustion Control for Industry."

Name \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_  
City and State \_\_\_\_\_







**"Here's How To Get  
FASTER  
TEMPERATURE  
MEASUREMENT"**

NEW BROWN  
Fast-Speed  
Thermocouple  
IS FASTER  
BECAUSE:



(1) Butt-welding replaces mass of metal at hot junction; (2) Shape of wire adjacent to junction holds back insulator, prevents it from dissipating heat and affecting response of the thermocouple.

Depending upon the application, this *Fast-Speed Thermocouple* is  $1\frac{1}{2}$  to 9 times faster than conventional type thermocouples.

In the picture you see Denny Somers, Honeywell Supplies Man of our Philadelphia office, telling a customer all about the new Brown *Fast-Speed Thermocouple*... after describing all of the benefits of the HSM Plan for buying pyrometer supplies.

You'll be pleasantly surprised when you learn how the plan can add convenience and economy to your pyrometer supplies purchasing, too!

There's a Honeywell Supplies Man near you... at your local Honeywell office... no further away than your phone. Call him in today, and you'll take an easy step in the right direction!

MINNEAPOLIS-HONEYWELL REGULATOR CO., Industrial Division, 4503 Wayne Ave., Philadelphia 44, Pa. Stocking points in Philadelphia, Cleveland, Chicago, Atlanta, Houston, Los Angeles, and San Francisco.

**MINNEAPOLIS  
Honeywell**

*Brown Instruments*



CARL-MAYER HIGH TEMPERATURE FURNACE, recirculating air heater type, for temperatures up to 1200°F., as installed for Timken Roller Bearing Company. • We also build Conveyor and Batch Type Furnaces up to 2000°F., for heat treating, normalizing, drawing, etc., using gas, oil and other fuels. • Our many outstanding achievements make it well worth your while to consult Carl-Mayer Engineers on your next installation.

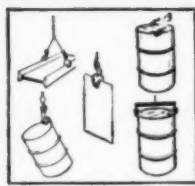
**The CARL-MAYER Corp.**  
3030 Euclid Avenue, CLEVELAND, OHIO.

**MERRILL  
MATERIALS HANDLING  
DEVICES**

4  
SIZES



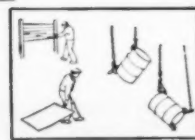
LIFTING CLAMP



TWIN LIFTER



HAND GRIP



4  
SIZES

DRAG CLAMP



DRUM TILTER



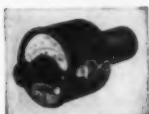
DRUM OPENER

**MERRILL BROTHERS**

56-31 ARNOLD AVE., MASPETH, N. Y.

## WHY GUESS THE TEMPERATURE

... when you can see it!



### THE NEW PYRO RADIATION PYROMETER

Just  
sight it ...  
and press the  
button!

Tells spot temperatures instantly in heat-treating furnaces, kilns, forgings and fire boxes. No thermocouples, lead wires or accessories needed! Temperature is indicated on direct-reading dial at a press of the button. Any operator can use it. In two double-ranges for all plant and laboratory needs.

Model No. 1: 1000-1800° F. and 1800-2600° F.  
Model No. 2: 1400-2400° F. and 2400-3400° F.

Write for FREE Catalog No. 100.

### PYRO OPTICAL PYROMETER

*Accurate temperatures at a glance!*

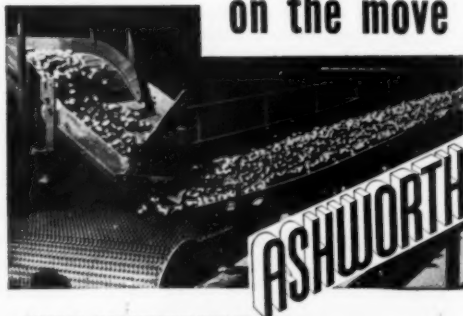
Any operator can quickly determine temperatures on minute spots, fast-moving objects and smallest streams. Completely self-contained. No calibration charts or accessories needed. An accurate, direct-reading Pyrometer that pays for itself by helping prevent spoilage. Weighs 3 lbs. Available in 5 temperature ranges (1400° F. to 7500° F.). Write for FREE Catalog No. 80.

### THE PYROMETER INSTRUMENT COMPANY

New Plant and Laboratory  
Bergenfield 8, N. J.



## Keep Your Product on the move



### METAL CONVEYOR BELTS

can help offset increased production costs by keeping your products on the move... increasing your hourly production! The right metal belt for your job means longer operating periods between maintenance shutdowns, longer belt life, greater economy!

Ashworth Engineers and Builds all  
Types of Wire Belts for Industry.

WRITE FOR  
ILLUSTRATED  
CATALOG 47P

### ASHWORTH BROS., INC.

METAL PRODUCTS DIV. • WORCESTER, MASS.

Sales Engineers located in: Buffalo • Chattanooga • Chicago • Cleveland • Detroit  
Los Angeles • New York • Philadelphia • Pittsburgh • Seattle  
Canadian Rep., PECKOVER'S LTD. • Toronto • Montreal • Halifax • Winnipeg • Vancouver

## FAHRITE heat-resisting castings for unusually high temperatures

In the most  
severe applications,  
where thermal shock is  
greatest, you'll find rugged,  
economical FAHRITE  
castings giving top-notch service.

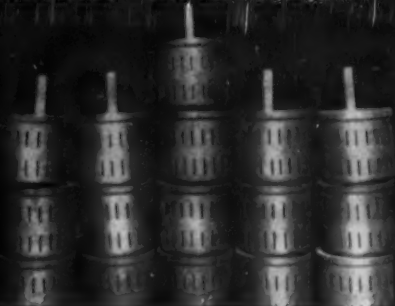
There are grades of FAHRITE  
for many conditions.

You can rely on the  
recommendations our  
engineers will make.



### THE OHIO STEEL FOUNDRY CO.

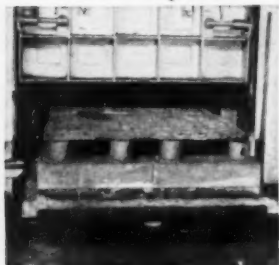
SPRINGFIELD, OHIO Plants at Lima and Springfield, O.



# Here's the most convenient way to make Refractory Concrete:



+



★ CAR TOPS

★ ARCHES



★ SPECIAL SHAPES

★ CORE OVEN FLOORS



★ HEAT TREATING FURNACES

★ DOOR LININGS

**IT'S THAT SIMPLE**—Castable Refractories completely eliminate the need of finding suitable aggregates . . . and grading them to the right sizes. Packaged Castables come to you with Lumnite® calcium-aluminate cement and selected aggregates already mixed—needing only addition of water. The resulting Refractory Concrete reaches service strength in 24 hours or less.

This convenient way of making Refractory Concrete speeds work and cuts labor costs. It simplifies tough jobs—and some Castables are suitable for use at temperatures of 3000°F. or higher.

**REFRACTORY CONCRETE** made with Castables is the adaptable refractory. Easy to place in any size or shape.

No cutting or fitting necessary when you pour

furnace walls, door linings and special shapes. There's no volume change to bother about. Build heat-resistant floors, furnace walls, arches and hearths—Refractory Concrete withstands severe thermal shock, resists spalling.

In fact, you'll find Castables tailor-made for speed and convenience on many Refractory Concrete jobs. Handy for repairs, too.

**CASTABLES** to meet specific temperature and insulation requirements are made by manufacturers of refractories and sold by their distributors. For further information, write to LUMNITE DIVISION, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

•• LUMNITE® is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.

MP-L-54

**ATLAS®**

**LUMNITE for INDUSTRIAL CONCRETES**

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT



"THE THEATRE GUILD ON THE AIR"—Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—NBC Network

# "no more GAMBLING on tool steel selection"



[1/2 actual size; Selector is in 3 colors]

## Here's how it works:

To use the Selector, all you need know is the characteristics that come with the job; type and condition of material to be worked, the number of pieces to be produced, the method of working, and the condition of the equipment to be used.

### FOUR STEPS—and you've got the right answer!

1. Move arrow to major class covering application
2. Select sub-group which best fits application
3. Note major tool characteristics (under arrow) and other characteristics in cut-outs for each grade in sub-group
4. Select tool steel indicated

That's all there is to it!

## Here's an example:

**Application**—Deep drawing die for steel

**Major Class**—Metal Forming—Cold

**Sub-Group**—Special Purpose

**Tool Characteristics**—Wear Resistance

**Tool Steel**—Airdi 150

One turn of the dial does it!

And you're sure you're right!!

Since the first announcement, hundreds of tool steel users have received their CRUCIBLE TOOL STEEL SELECTORS. The comments received indicate that this handy method of picking the right tool steel right from the start is going over big.

"Handiest selector I've ever seen"

"No more gambling on tool steel selection"

"You're right, the application should dictate the choice of the tool steel" . . . and many, many more favorable comments.

You'll want your CRUCIBLE TOOL STEEL SELECTOR. It uses the only logical method of tool steel selection—begin with the application to pick the right steel! And the answer you get with one turn of the Selector dial will prove satisfactory in every case, for the CRUCIBLE TOOL STEEL SELECTOR covers 22 tool steels which fit 98% of all Tool Steel applications. ALL the tool steels on the Selector are in Warehouse Stock . . . that means when you get the answer, you can get the steel . . . fast!

Write for your Selector today! We want you to have it, because we know you've never seen anything that approaches your tool steel problems so simply and logically. Just fill out the coupon and mail. Act now! CRUCIBLE STEEL COMPANY OF AMERICA, Chrysler Building, New York 17, N. Y.

Crucible Steel Company of America  
Dept. MP, Chrysler Building  
New York 17, N. Y.

Gentlemen:

Sure! I want my CRUCIBLE TOOL STEEL SELECTOR!

Name \_\_\_\_\_ Title \_\_\_\_\_

Company \_\_\_\_\_

Street \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_

# CRUCIBLE

first name in special purpose steels

## TOOL STEELS

fifty years of *Fine* steelmaking

Branch Offices and Warehouses: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI • CLEVELAND • DENVER • DETROIT • HOUSTON, TEXAS • INDIANAPOLIS • LOS ANGELES • MILWAUKEE • NEWARK • NEW HAVEN • NEW YORK • PHILADELPHIA • PITTSBURGH • PROVIDENCE • ROCKFORD • SAN FRANCISCO • SEATTLE • SPRINGFIELD, MASS. • ST. LOUIS • SYRACUSE • TORONTO, ONT. • WASHINGTON, D. C.

# Do you have an ammonia problem?



With increased use of nitriding on aircraft parts and other D. O.'s, maybe you have an ammonia problem to add to your others.

It could be that your installation is not adequate for your increased hourly requirements. Or maybe your present flow control equipment, valves or gauges are not adaptable for use with ammonia. Perhaps you would like to know how to get all of the ammonia out of the cylinders. Or it could be so simple as instructing employees on the precautions to observe when handling ammonia. Any one of these things could be a problem.

Why not let your nearby Armour Technical Service man help you. His experience with these and other similar problems may easily provide the answer to yours. Write and tell us about *your* problem and also send for one or both of the booklets offered in the coupon.



*You can depend on  
Armour's Ammonia and Service*

**ARMOUR** *Ammonia Division*

Armour and Company, 1355 W. 31st St., Chicago 9, Ill.

Please send me a copy of:

- ☐ Ammonia Installations for Metal Treating  
☐ The Nitriding Process

Name \_\_\_\_\_ Title \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

# SARGENT-SLOMIN

*Electrolytic Analyzers*

★ IMMEDIATE SHIPMENT FROM STOCK



FOR  
HIGH SPEED  
QUANTITATIVE  
ANALYSIS  
OF...

- Ferrous and non-ferrous metals and alloys.
- Electroplating solutions and electro-deposits.
- Ores and minerals.
- Metals in biological materials.
- Metals in foods, soils, etc.
- Forensic materials.
- Micro and semi-micro specimens.

## Designed for continuous trouble-free performance

The Sargent-Slomin Electrolytic Analyzer represents a complete re-design of the original Slomin instrument. Each unit is mounted within a case consisting of a one-piece stainless steel panel, beaker platform and apron with sturdy end castings. All models are completely self-contained and operate from 50-60 cycle electric circuits—no auxiliary generators or rheostats are required.

The two position analyzers consist of two complete, independently operating analyzer circuits. Duplicate or check analyses can be run at the same time.

The central electrode is rotated by a new synchronous capacitor wound motor, operating at 550 r.p.m., especially engineered for this application.

Outstanding features of this rugged motor are:

Greater output than any motor of similar characteristics and size. No internal switches or brushes.

No "permanent" magnets — full output for long service life.

Fully synchronous — no speed change with change of load.

All parts of the new electrode chucks are made of stainless steel.

These analyzers used with the specially designed high efficiency corrugated electrodes rapidly produce smooth, close grained deposits at maximum current density.

**S-29460 ELECTROLYTIC ANALYZER**—Sargent-Slomin, One Position, with Heating Plate. For operation from 115 Volt, 50-60 cycle circuits .....**\$250.00**

**S-29465 ELECTROLYTIC ANALYZER**—Sargent-Slomin, Two Position, with Heating Plate. For operation from 115 Volt, 50-60 cycle circuits .....**\$395.00**

**S-29632 ANODE**—Platinum gauze, Corrugated Form, High Speed. (Patent pending.) Price subject to market.

**S-29672 CATHODE**—Platinum gauze, Corrugated Form, High Speed. (Patent pending.) Price subject to market.

## SARGENT

SCIENTIFIC LABORATORY EQUIPMENT AND CHEMICALS  
E. H. SARGENT & COMPANY, 135-145 EAST SUPERIOR ST. CHICAGO 11, ILL.  
MICHIGAN DIVISION 1950 EAST JEFFERSON DETROIT MICHIGAN





**OCT. 15-19**

**Detroit, Mich.**

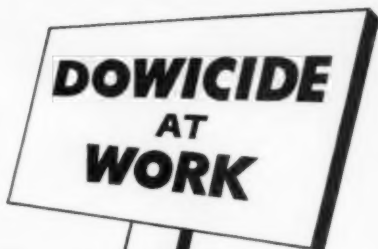
## **Keep this date with a Free World's Destiny**

For the first time in history, the metal scientists of the nations of the free world will meet to exchange ideas and discuss techniques of higher production under critical metal shortages. Because this is the first time a thing so meaningful and so unusual in international relations has been achieved, you'll not want to miss it—you'll find the World Metallurgical Congress technical sessions fascinating proof of the free world's need for better understanding and better fellowship. Be an eyewitness at this history-making event.

**NATIONAL METAL  
EXPOSITION**

**NATIONAL METAL  
CONGRESS**

**WORLD  
METALLURGICAL  
CONGRESS**



give mold and bacteria the boot  
with  
**DOWICIDE  
PRODUCTS**

You can protect soluble oils from mold and bacterial attack by giving them the "boot" with Dowicide products. When you use these Dow industrial germicides and fungicides, you put an end to production delays and material wastes caused by soluble oil emulsions and coolants going "sour."

It means that you'll no longer be bothered by rusted parts and machines, clogged drains and pipes that are the result of emulsion breakdown due to bacterial action. There are substantial savings in machine down-time and man hours, formerly required to replace "sour" emulsions and clean up equipment. Add to these preventative features the plus factor of greater service life for your soluble oil emulsions and you will realize it costs you money not to incorporate Dowicide products in your soluble oil emulsions and coolants. Give mold and bacteria the "boot" today by putting these products to work in your plant.

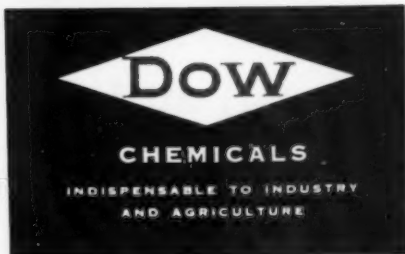
Dow maintains complete laboratory facilities to help you solve your problems. Contact your nearest sales office or write direct to Midland.

**THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN**

New York • Boston • Philadelphia • Washington • Atlanta • Cleveland • Detroit  
Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle  
Dow Chemical of Canada, Limited, Toronto, Canada

Salmonella Typhosa  
Bacteria

Use  
**DOWICIDE**  
Industrial  
Germicides and Fungicides



# Reynolds ALUMINUM REPORTER

★★★ Seventh in a Series to Industry on Aluminum Uses and Developments ★★★

## HEAT-TREATABLE ALUMINUM EXPANDS USES

### Aluminum Pipeline in Use 1½ Years Shows No Corrosion

Recent uncovering of the 40-foot bare aluminum by-pass installed approximately eighteen months ago in the Alabama-Tennessee Natural Gas Company's 8-inch aluminum pipeline revealed absolutely no discoloration or corrosion of any sort.



Unretouched photograph showing aluminum pipeline section after seventeen months underground.

This section of pipe was installed without any protective coating or wrapping to test the natural corrosion-resistance of aluminum.

Careful inspection both inside and outside was made to determine any sign of wear or corrosion. No corrosion of any type could be found on the outside, where the bare pipe was in contact with the soil; nor on the inside, which carried natural gas. The test period was approximately eighteen months.

Supervised by officials of the gas company and Reynolds, this inspection showed that aluminum pipe would last indefinitely under such conditions. Soil analyses were taken along with the test section and are available upon request from Reynolds Metals Company.



Aluminum pipeline after being removed from ground. Note absence of corrosion in this unretouched photo.

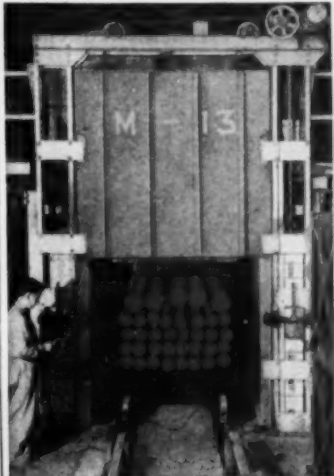
For further information on how the adaptability and corrosion resistance of aluminum can be applied to your product or problem, contact the Reynolds office or distributor listed under "Aluminum" in your classified telephone directory. Or, write to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

### Four Part Book Has Valuable Information for Both Non-Technical Men and Metallurgists

Until recently, little information has been available on methods of heat treating the aluminum alloys. There has been a great need for this information since aluminum has become one of America's foremost metals.

The improved strength, hardness and temper of heat-treatable aluminum, especially the comparatively new 75S alloy, have greatly expanded the use of this lightweight metal in almost all industries. Now aluminum can be used in more places and for more purposes than ever before.

A 144-page illustrated book, "Heat Treating Aluminum Alloys," that brings together all the latest information on the subject in a form readily usable by both the non-technical man and the highly trained technician is now available from the Reynolds Metals Company.



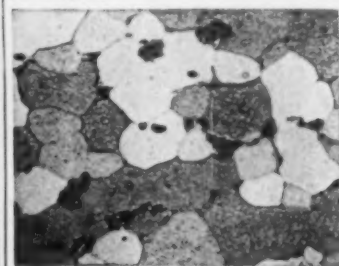
A 30,000 pound soaking furnace for handling billets. Note connections to thermocouples imbedded at various points in the load.

The book was prepared with the assistance and collaboration of some of the country's leading metallurgists and organizations. It contains photomicrographs, like the one in the column at right, showing the crystal structure for various treatments and alloys.

Divided into four parts for ready understanding and use, the book is handy for both desk and shop reference. Section One breaks down the subject into easily understandable concepts for the non-technical reader. Section Two presents in brief tabular form the recommended heat-treating cycles for specific aluminum alloys. Section Three is a technical discussion of the various treatments, possible

difficulties and their cure. Section Four contains tables of mechanical properties for both wrought and cast alloys.

Application of the methods described in this book can improve the quality of your product and mean more profit for you through fewer rejects.



Structure of incorrectly heat-treated aluminum alloy R301. Excessively high temperature resulted in melting certain constituents at grain boundaries. Kellers etch, 500 X.

And if you have a special problem on design or fabrication with aluminum, take advantage of the trained staff of Reynolds Aluminum specialists waiting to help you. For prompt service, call the Reynolds office or distributor listed under "Aluminum" in classified telephone directories.

(Instructors are invited to request copies of this book for their senior and graduate engineering students. A 24-page condensation is also available without charge to other students.)

For your free copy of the valuable handbook, "Heat Treating Aluminum Alloys" plus a complete index of Reynolds technical literature, request today on business letterhead (otherwise price is \$1.00). Write to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

MORE INTERESTING NEWS ABOUT ALUMINUM ON NEXT PAGE

(Advertisement)

Printed in U. S. A.

## Roll-Formed Sections Ideal for Many Aluminum Applications

The continuous process of cold roll-forming aluminum into sections of various shapes is one of the valuable services made available to manufacturers by Reynolds Parts Division.

In many assemblies, the use of long roll-formed sections results in more efficient operations and a considerable scrap saving. Accuracy of roll-formed parts is usually maintained more closely than that of parts produced by other forming processes, thereby promoting interchangeability. Clear smooth finishes are easily obtained by roll-forming.



These advantages have been found to be of tremendous value to users of mouldings, structural parts, angles, channels, hat sections, zees, butt seam tubing, lock seam tubing and many miscellaneous shapes.

Among these users are manufacturers of automobiles, railroad and marine equipment, busses, trucks, trailers, aircraft, farm and ranch gates, clothes dryers, scaffolding, ladders, screens, storm sash, television antennae, masts, siphon tubing, building products and many others.

For example, the Reynolds Fabricating Service furnishes roll formed hat sections to the Alproco Company of Mineral Wells, Texas. These sections are the basis for an all-aluminum ranch and farm gate sold in great numbers by this company throughout the West. The sections are used for vertical, horizontal and diagonal members of the gate.

This is only one example of the valuable service made available to manufacturers through the use of the Reynolds Parts Fabricating Service. Formed or partially formed parts are delivered to the manufacturer ready for finishing and assembly, resulting in scrap savings averaging 30%—often as high as 75%—plus valuable time savings.

Reynolds Parts Fabricating Service is a complete service with equipment for shearing, forming, drawing, tube bending, roll-forming, roll shaping, riveting, welding and finishing. The Service is set up to work with all manufacturers, regardless of size, to secure coordination of all resources to expand the nation's production capacity on defense orders.

For complete information on how the Reynolds Parts Fabricating Service can help you, write for the free booklet, "Pounds of Parts... instead of Pounds of Metal." And for assistance on your particular requirements, call the Reynolds office listed under "Aluminum" in your classified telephone directory. Or, write Reynolds Metals Company, 2065 South Ninth Street, Louisville 1, Kentucky.

Be sure to see our booth, F-325, at the Metal Exposition—Detroit, October 15-18. We'll be pleased to answer your aluminum design or fabrication questions—and show you a host of aluminum improved products.

Printed in U.S.A.

## Aluminum Pigments Offer Variety of Finishes For Beauty, Protection and Durability

If your product cannot be made of aluminum, the next best thing is to take advantage of one of several attractive aluminum finishes.

When mention is made of aluminum paints, the usual thought is of the bright, silvery surface most often seen in "leafing" type paints. But there are other types of aluminum pigment finishes, chief among which are the "wrinkle," "hammered metal" and "polychromatic" types.

The "wrinkle" type is widely used for an attractive, glare-free finish on such objects as typewriters and other office machines.

This finish is produced by coating the metal with a special opaque paint to which "non-leafing" aluminum pigment has been added. The wrinkled effect is achieved by a short baking operation. Advantages of this type of finish are the glare-free surface and defect-hiding properties. Minor surface scratches are hidden without buffing.

The "hammer" type finish, so called from its resemblance to the effect achieved by light tapping on metal with a ball-peen hammer, is widely used to obtain a smooth, easily cleaned surface with multi-colored effects on such objects as thermos jugs, ashtray stands, automatic vending machines, lawn mowers, etc. This finish will also cover minor surface



defects. The "non-leafing" aluminum pigmented paint is formulated in such a manner that, having been sprayed on the object and left to dry, the paint automatically produces a "crater" or "hammered" effect.

The third finish, widely used for its lustrous beauty, is the "polychromatic" coating. This finish is in great demand for automobiles because of the added durability and beauty imparted by the reflective aluminum pigment. "Non-leafing" aluminum flakes remain suspended in the transparent color lacquers or enamels giving a metallic iridescence. Examples of this type of pigment finish are the sparkling, jewel-like colors you see more and more on the late model automobiles. Polychromatic effects are also favored for plastic materials such as shower curtains, chair-coverings, raincoats, etc.

To learn more about these attractive and durable finishes, call the Reynolds office listed under "Aluminum" in your classified telephone directory. Or, write to Reynolds Metals Company, 2576 South Third St., Louisville 1, Ky.



## Aluminum Gains in Favor for Curtain Wall Construction

The term "curtain wall" is a designation for non-structural closures for the structural frame work of modern buildings.

Curtain wall panels are prefabricated units of insulation material sandwiched between facings of plain or decoratively embossed aluminum—or aluminum for the exterior and other finishing material inside—similar to plywood but considerably thicker.

There are several curtain wall panel designs with varying methods for interlocking and sealing. A number of factory and office buildings have already employed this new construction method with highly satisfactory results.

The advantages of aluminum for curtain walls are apparent. Light weight combined with great strength, natural attractiveness and resistance to rust and corrosion make aluminum an ideal material for modern construction.

A Reynolds Aluminum Specialist will be glad to discuss all the advantages of aluminum in your products. Call the Reynolds office or distributor listed under "Aluminum" in your classified telephone directory or write to Reynolds Metals Company, 2576 So. Third St., Louisville 1, Ky.



Reynolds Wrap is now "all out" for defense

Return Flight Guaranteed!

## Reynolds Developing World's Biggest Bauxite Deposit in Jamaica, B.W.I.

A 40,000 to 50,000 acre tract of Jamaican real estate has been acquired by Reynolds Jamaica Mines, Ltd., a subsidiary of Reynolds Metals Company. The tract is said to contain by far the most important bauxite ore body ever discovered. This deposit has enough bauxite to furnish the United States with low-cost aluminum for many decades.

The extensive Jamaican mining project involves total expenditures of about 14½ million dollars. Construction of a pier and harbor facilities, a drying plant, overhead tramways and other auxiliary equipment is well underway and scheduled for completion early in 1952. Net result will be a reliable source of bauxite to supply the U. S. with low-cost aluminum for generations to come.

The use of low-silica Jamaican ore to supplement high-silica Arkansas bauxite will also permit the use of even lower grades of domestic bauxite than are presently regarded as usable, and will correspondingly enlarge the effective reserve.

Most of the bauxite used in the U. S. by companies other than Reynolds now is imported from Dutch Guiana, a distance of about 2500 miles. Jamaica is located only 1000 miles from Gulf ports in the U. S.

(Advertisement)

# "Increased Production ...Improved Quality"

## ... says large tool company

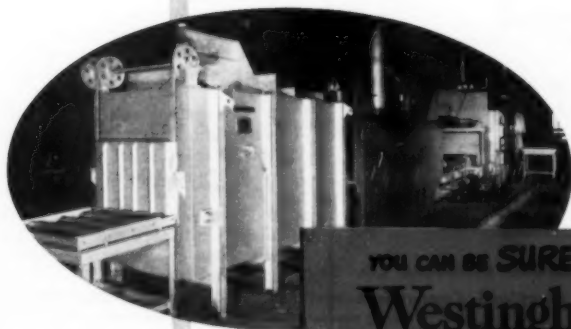
"Stepped up production and improved the quality of our products," says a large tool company of this Westinghouse electrically heated, gas carburizing furnace. Steel parts ... of a wide variety of shapes and sizes ... are carburized, quenched, washed, drawn and discharged. Operation is straight line and completely automatic.

The result: Precise, *uniform* carburization of all parts, faster operation, and elimination of bottlenecks caused when trays must be manually removed.

A Westinghouse gas-fired Endogas generator provides the proper, safe controlled atmosphere. In addition, all auxiliary equipment is also Westinghouse, including motors, controls and material handling equipment ... *a complete "packaged" installation from a single source.*

Gas-fired or electric, there's a Westinghouse furnace to meet every heat-treating need. Westinghouse Electric Corporation, Industrial Heating Works, Meadville, Pennsylvania.

J-10369



IF YOUR PRODUCT CALLS FOR  
HEAT-TREATING ... IT CALLS  
FOR A WESTINGHOUSE FURNACE ...  
GAS OR ELECTRIC

YOU CAN BE SURE... IF IT'S

**Westinghouse**

**HEAT-TREATING FURNACES**



SEE THE WESTINGHOUSE FURNACE EXHIBIT  
AT THE METAL SHOW, BOOTH G-430



## Effect of Sinter on Blast Furnace Production\*

A METHOD is submitted for determining the effect of sinter on blast furnace production, with the use of statistical analysis of daily operating data. For this purpose, a statistical study was made, using 1000 daily values from a blast furnace having a hearth diameter of 18 ft. and a capacity of 800 tons per day.

It has been clearly indicated by

a recent survey of sinter plants that the effect of using sinter in the blast furnace is difficult to evaluate. This is because the true effect is usually more or less obscured by the influence of other operating factors.

The study was made by analyzing the two variables, blowing rate and efficiency, and their related factors as shown in the tabulation:

- I. Blowing rate (cu.ft. of air per day).
  1. Physical characteristics of coke.
    - a. Size, shatter, stability, etc.

2. Physical characteristics of metallic burden.
  - a. Hardness and size distribution of ore.
  - b. Percentages of sinter, scrap, etc.
3. Mechanical delays.
- II. Efficiency (cu.ft. of air per ton of iron).
  1. Richness or iron content of burden.
    - a. % sinter.
    - b. % scrap.
    - c. % any special materials.
  2. Slag volume.
    - a. Silica and other gangue in metallic burden.
    - b. Ash and sulphur in coke.
  3. Reducibility of ores.
  4. Moisture in blast.
  5. Required analysis of iron.
    - a. Silicon, manganese and sulphur.
  6. Stock column movement.
    - a. Smooth or rough.

Benefits from sinter would be expected to come in two ways. First, it would increase the iron content of the burden. Secondly, it would be expected to give more voids of uniform character in the ore layers which should contribute to increased gas-solid contact in the stack. This should help to offset the loss of reducibility attributed to the use of sinter. Whether it actually does or not is still a question to be answered.

The influence of sinter on operating characteristics is shown graphically in five separate figures. Respectively, they indicate:

1. If the amount of metallic burden plus flux required to make a ton of pig iron can be decreased by 100 lb., production will increase 16 tons per day on the specific furnace involved.
2. Each per cent of sinter in the burden will decrease the total material required by about 8 lb. per ton of iron produced. Also at 50% sinter, total material required is decreased by 400 lb. per ton of iron and production increased 64 tons per day.
3. Correlating per cent sinter directly with pig iron production shows an increase of 57 tons pig iron per day when using 50% sinter.
4. Plotting blowing rate against efficiency indicates the optimum blowing rate consistent with maximum production.
5. Comparing characteristic curves for two sinter levels shows

(Continued on p. 164)

\* Abstract of "The Effect of Sinter on Blast Furnace Production as Determined by Analysis of Daily Operating Data", by W. E. Marshall, a paper presented before the General Meeting of the American Iron and Steel Institute at New York, May 23-24, 1951.

**BLACK MAGIC** meets every **BLACK OXIDE** specification

**GOVERNMENT SPECIFICATIONS**  
57-0-2C Type 3  
51-70-1A Finish 22.04

**Aeronautical Material Specification AMS 2485**  
and all other specifications calling for a black oxide finish.

- Easily blackens heat treated parts.
- One bath! One salt!
- Lower operating temperature.
- Self rectifying.
- Faster blackening cycle.
- More corrosion resistant.

Write for Bulletin MB-3

Send items of your own manufacture for sample processing.

**Mitchell-Bradford**

**THE MITCHELL-BRADFORD CHEMICAL CO.**  
2446R Main St. Stratford, Connecticut

Sales and Technical Service also available at our Chicago office: 7001 North Clark. Representatives in all leading cities.

**QUALITY PRODUCTS OF CHEMICAL RESEARCH**

# For more profitable heats *choose* **IMMERSION RAYOTUBE or IMMERSION THERMOCOUPLE**



**to measure temperatures in the steel bath**



THE IMMERSION RAYOTUBE is plunged beneath the surface of the bath . . . sights on an air pocket blown in the steel . . . reports temperature to a Speedomax Recorder.



THE IMMERSION THERMOCOUPLE is immersed until couple reaches bath temperature . . . a process guided by signal lights and charted on a Speedomax Recorder.

Open hearth and electric furnace shops can now choose between two tested L&N methods for measuring steel temperatures during the melt. Either the Immersion Rayotube or Immersion Thermocouple is plunged momentarily beneath the surface to measure the interior temperature of the bath, while a dependable Speedomax Recorder displays the information where all concerned can use it.

Either method helps improve ingot production by warning if the steel is too hot or too cold for normal pouring. Authorities\* have found that some ingots from as many as 44% of overheated melts will stick to the molds, resulting in loss of production time, while as many as 52% of underheated melts will lose yield through formation of skulls in the ladle. Both of these losses have been sharply cut in every plant where temperature is properly measured while the melt is finished off for tapping.

Investigate the choice of immersion methods L&N offers to meet plant requirements. In general, Rayotubes are employed in heavy-duty shops where several readings may be taken every hour, while thermocouples—although sometimes preferred for such service—find wider application to small or special furnaces. However, a number of factors determine the final choice. Let our experienced engineers analyze your measurement problems and help your staff select the proper equipment.

Contact our nearest office, or write us at 4927 Stenton Avenue, Philadelphia 44, Pa.

\* Clark and Feigenbaum of J&L, in AIMME Technical Paper 2031.

LEEDS  NORTHROP

Jel Ad N-33-640(2)

OCTOBER 1951; PAGE 163

## Effect of Sinter on Blast Furnace Production

(Continued from p. 162)

Operating Data

TEST GROUP	BLOWING RATE M CU.FT. PER MIN.	AIR CU.FT. PER TON	COKE LB. PER TON	PRODUCTION TONS PER DAY
Original	52.6	90.7	1632	842
Low sinter	53.0	91.3	1634	844
High sinter	52.1	90.1	1630	840

Burden Data

TEST GROUP	COMPOSITION OF BURDEN				METALLIC BURDEN	FLUX
	SINTER	SCRAP	MISC.	ORE		
Original	54.8	6.6	6.8	31.8	3418	726
Low sinter	47.7	6.9	7.1	38.3	3449	722
High sinter	61.9	6.4	6.6	25.1	3387	729

that a higher sinter burden causes lower efficiency to set in at a lower blowing rate.

For further study of the effect of sinter, the 1000 daily values were split into two sets of 500 each, so that one set contained low values and the other high

values of sinter. The average values of the two sets of 500 and the original set of 1000 are shown in the tables.

There is appreciable difference in production and coke rate between the low and high values of sinter. However, the air per ton of iron was 1200 cu.ft. less in the case of high sinter, even with 0.5% less scrap. The average blowing rate was also slightly less for the high sinters. Had it not been for these two factors, production would have been 12 to 15 tons more per day for the higher sinters.

The foregoing procedure has been presented, not as a general solution to the problem of sinter utilization for everybody, but to demonstrate the necessity for serious effort to find out what kind of sinter is best for the blast furnace, and how to make it. This technique is one that will give more information and understanding about any blast furnace burden.

Characteristics of sinter will vary from company to company and plant to plant, depending on the materials available for its making and what it replaces in the burden. An industry-wide program to evaluate sinter is faced with a good many organizational difficulties. Adequate sampling and testing of such a nonuniform product would cover a long period of time and be expensive.

If such a program is organized, each company participating might do as follows:

1. Make the kind of sinter he believes best.
2. Describe this sinter for the experimental period with agreed tests, adequate in number to show the significant differences between sinter made at the various plants.
3. Run a blast furnace test at each plant comparing agreed percentages of sinter in the burden to an all-ore burden composed of ores that would be used if sinter were unavailable.

(Continued on p. 166)

**Minimize machining  
reduce waste with**

**MILNE'S**

**Kolorkote**

**HOLLOW DIE STEELS**

HI-CARBON

HI-CHROME

AIR  
HARDENING

WATER  
HARDENING

OIL  
HARDENING

- For any given finished sizes, MILNE Hollow Die Steel weighs 13 to 20% less than corresponding ring forgings.
- Stocked in 3 grades.
- Sizes from 16" OD x 12" ID to 2" OD x 1" ID.
- Prompt deliveries from warehouse stocks.
- Cut to any length.
- Free from decarb.
- Rough turned OD x ID and saw cut faces.
- Every bar furnace-annealed... no scale.
- Write for catalog.

★ Full length spray-painted with permanently identifying color.

★ Heat treat card of matching color with each shipment.

**Plan To Visit Us At**

**BOOTH A-356**

**National  
Metal Show**

Detroit, Michigan  
October 15th-19th

**DETROIT SALES AGENTS**

**SEVARD METALS**

915 Fisher Building, Detroit, Michigan

Tel. TRinity 5-1730

Warehouse Stock

**A. MILNE & CO.**  
Chicago & Cleveland

**A. MILNE & CO.**

745 WASHINGTON ST., NEW YORK 14, N.Y.

American & Canadian Tool Steel Specialists  
Complete Line of Tool Steels, High Speed Steels, and Inconels

# ALL TINNEMAN



# Speed Nuts®

*are heat treated in*

# NICHROME\* MUFFLES

Cast and fabricated Nichrome muffle, of the type used in all Tinnerman's reciprocating controlled-atmosphere ("shaker hearth") furnaces. Weight: approximately 1,400 lbs.

Such muffles have served as long as 12,000 hours without requiring attention—at temperatures in excess of 1700°F.



Every shaker hearth furnace used in heat treating the Tinnerman "SPEED NUT" brand of fasteners—universally used in a host of applications—is equipped with a Nichrome muffle!

In the all-important heat treating phase of manufacture at Tinnerman, the reliance placed upon Nichrome muffles is best expressed in the words of Mr. S. J. Andrews, Works Manager: "Nichrome muffles," he says, "stand up under intense heat and give maximum service."

Whatever your heat treating requirements, consult with us. For over 30 years, we have been engineering and casting heat-resisting nickel-chrome-alloys—helping manufacturers to *reduce heat-hour costs* with equipment unexcelled for efficiency, economical service, and long life. Although the present emergency is making unprecedented demands upon the resources of Driver-Harris Company, we shall be glad to make recommendations based upon your specific needs, and serve you to the best of our ability.



Battery of reciprocating, controlled atmosphere furnaces at the new Cleveland, Ohio plant of Tinnerman Products, Inc. (A) Charge ends; (B) Discharge ends.

Furnaces manufactured by  
American Gas Furnace Company, Elizabeth, N. J.



Nichrome\* is manufactured only by

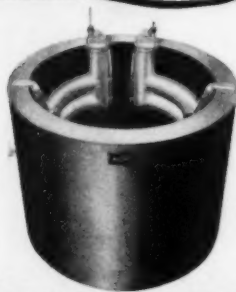
## Driver-Harris Company

HARRISON, NEW JERSEY

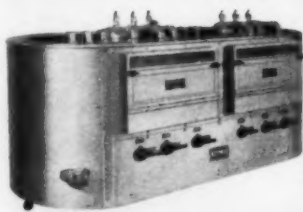
BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

\*T. M. Reg. U. S. Pat. Off.

# KEMP Immersion Melting Pots melt metals at Lowest Cost



- 44" pot with 10,000 lb. capacity.
- Casting rate: two tons per hour.
- Estimated fuel savings of up to 40%.



- Newspapers report actual savings of from 50% to 60% on fuel with 10-ton capacity melting pot shown above.

## • SAVE YOU UP TO 40% ON FUEL ALONE

If you melt soft metals, lead, pewter, tin or salt, you can now cut your melting costs to rock bottom. Actual cases prove that modern Kemp Gas-Fired Immersion Heating cuts fuel bills up to 40% and more. Reduces heat recovery time to 1/3—assures high thermal efficiency for both large and small units.

### POSITIVE HEAT CONTROL

There's no brickwork to steal heat—no external combustion chamber—no carbon monoxide—no temperature overrun. You get high melting rates, reduced dross formation and speed of temperature recovery after adding cold material. The Kemp Industrial Carburetor, part of each installation, assures complete combustion—reduces installation costs.

### SEND FOR DETAILS

Get the facts. Find out how much you can save—how Kemp Immersion Melting Pots can improve your melting operation.

# KEMP IMMERSION MELTING POTS

OF BALTIMORE

Write for Bulletin for technical information.  
Address: C. M. KEMP MFG. CO.  
405 E. Oliver St., Baltimore 2, Md.

QUICKSTARTERS • BURNERS • FUEL CHECKS • ATMOSPHERE & INERT GAS OPERATORS  
ADSORPTIVE DRYERS • METAL MELTING UNITS • SPECIAL EQUIPMENT

## Effect of Sinter on Blast Furnace Production

(Continued from p. 164)

4. Conduct the blast furnace test in such a way that (a) the relation between blowing rate and efficiency, (b) blowing rate and production, and (c) blowing rate and flue dust can be obtained for each burden.

5. From this information it will be known whether sinter (a) permits higher blowing rates without loss of efficiency, thus increasing production more than its increased iron content would do alone, (b) increases efficiency and production only proportional or less than proportional to its iron content, (c) permits higher blowing rates without increasing dust losses.

Such a program might be viewed askance in fear of lost production. Nevertheless, until it is carried out, the sinter situation will continue to be confused. Actually, if such a test were carefully planned, the variation introduced by it might have no more effect on annual production than unforeseen and unplanned difficulties that always occur.

A. J. HOCH

## Tensile Strength of Warm Worked Austenitic Steel\*

WROUGHT ALLOY G18B, developed in England during the war for high-strength high-temperature application as disks in jet engines, has been improved materially by "warm working" at temperatures within the precipitation range. This steel has the following composition: C 0.4, Mn 0.8, Si 1.0, Ni 13.0, Cr 13.0, Co 10.0, W 2.5, Mo 2.0, and Cb 3%. As engine operating conditions became more severe, excessive stretch occurred at the comparatively cool center of G18B disks and an effort was made to improve the inherently low proof stress without adversely affecting the adequate high-temperature creep and rupture strengths. Age hardening and cold working improved room-temperature proof stress materially, but respectively lowered and gave erratic improvements in creep strength along with lower rupture strength. Experiments with warm working, both on

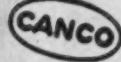
(Continued on p. 168)

\*Abstract of "Effect of Warm Working on an Austenitic Steel (G18B)", by G. T. Harris and W. H. Bailey, Symposium on High Temperature Steels and Alloys for Gas Turbines, Iron and Steel Institute, February 1951, p. 60.





Remington Rand



Many of the distinguished high quality products identified by these famous trade-marks are efficiently and economically produced with...

# THER-MONIC

ELECTRONIC HEATING EQUIPMENT

You, too, can enjoy the same quality and satisfaction by entrusting your foundry core baking and heat treating problems to the largest producers of electronic heating equipment!

## INDUCTION HEATING CORPORATION

181 WYTHE AVENUE • BROOKLYN 11, N. Y.

Induction, Dielectric and Foundry Core Baking Equipment.

## Tensile Strength of Warm Worked Austenitic Steel

(Continued from p. 166)

an experimental and production basis, indicated that both the low and high-temperature properties of G18B were improved with this treatment.

**Experimental Warm Working**—Investigation was made of the response of solution treated (at 2370° F.) bar stock of G18B to warm working (a) by pressing between flat dies, (b) in tension, and (c) by stamping in closed dies. From the work in flat dies between 1200 and 1650° F. it was found that the properties improved with increasing warm working stresses, and that these stresses should be higher than the proof stress at the warm working temperature to produce a marked improvement in properties. There was an indication that deformation during warm working

Effect of Warm Working

WARM WORKING METHOD	0.1% PROOF STRESS	CREEP TEST*	
		CREEP RATE†	RUPTURE TIME‡
Solution treated	31,400	300	100
Solution treated and aged	44,800	>1000	15
Pressing	72,800	..	..
Tension	87,400	11	710
Drop stamping	70,300	2	560

\*35,800 psi. at 1290° F. †Per hr. × 10<sup>6</sup>, minimum. ‡In hours.

## "MARVEL" HAS always had the edge



MARVEL High-Speed-Edge Blades assure Faster, more Accurate cutting with proven Economy and complete Safety. Only the MARVEL is a composite blade with a high speed steel cutting edge electrically welded to an exceptionally tough, strong alloy steel body.

The High-Speed-Edge does the cutting while the alloy back with hardened eyes carries the load. Blade tensions up to 300% higher than those possible with ordinary blades are recommended. This greater tension is confined to the cutting or leading edge by the location of pin holes (exclusive MARVEL design feature) and cannot be overcome by work resistance. Heavier feeds and greater speeds are practical without "run out".

With greater accuracy, higher production and lower cost per cut comes the extra dividend of Safety, for MARVEL High-Speed-Edge Hack Saw Blades are Positively Unbreakable—they will not shatter.

Ask your local MARVEL distributor (see classified phone book) to help you modernize your metal sawing with MARVEL High-Speed-Edge Blades. They cost no more than ordinary blades.

1. High Speed Steel cutting edge.

2. Tough unbreakable alloy steel body with hardened eyes.

1. & 2. Integrally welded to make a fast-cutting, long lasting composite blade that is positively unbreakable.

### ARMSTRONG-BLUM MFG. COMPANY

"The Hack Saw People"

5700 BLOOMINGDALE AVENUE • CHICAGO 39, ILLINOIS



could be used as a criterion for the amount of working applied.

Warm working in tension improved room-temperature proof stresses and hot rupture strength almost linearly with increasing total strain (at constant strain rate) up to 8% (and hence also with increasing stress). Working temperatures between 1110 and 1470° F. were not critical except in their influence on the stress applied to yield a given strain. While proof stresses were found to increase with decreasing strain rates (from 10<sup>-1</sup> to 10<sup>-3</sup> per min.) and constant strain, this may have been an age hardening effect resulting from the longer times at temperature for the slower rates.

Having established that warm working enhances the properties of G18B it was necessary to investigate the only available method of obtaining the stresses necessary in production of large disks—that of drop stamping in closed dies. While most of the deformation took place in the first one or two hammer blows, the proof stress continued to increase up to 24 blows. This indicates that total energy absorbed rather than amount of deformation controls the proof stress. Creep and rupture strengths were improved up to about six warm working blows, after which these properties became constant. Proof stress increased with working temperature only after more than ten blows, but rupture and creep strength reached an optimum at warm working temperatures around 1200 to 1290° F. after six blows. Warm working the alloy in the as-forged condition gave similar proof stress improvements to those on previously solution treated material, but rupture strengths were no better than for material that was not warm worked.

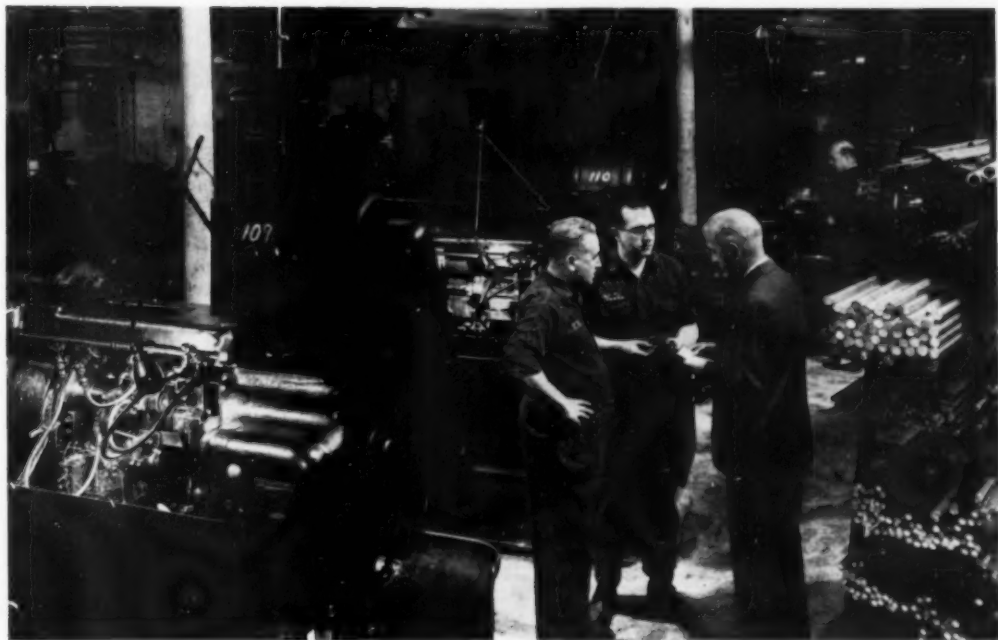
The maximum properties obtained by each of the three warm working methods are given in the table. Maximum proof stresses and creep properties in this table were not

(Continued on p. 170)

# "With **Gulf Electro Cutting Oil**

**we increased tool life from 5 to 8½ hours  
on stainless steel races"**

*says Herman Busch  
President, Buswell Metal Products, Inc.*

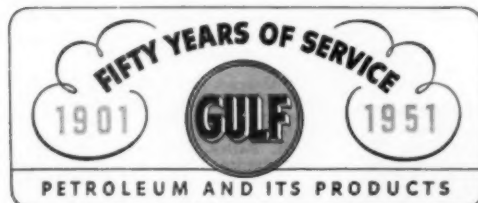


"We've found that the new Gulf Electro Cutting Oil is ideal for all-round service on 6-spindle automatics," says Mr. Herman Busch, President, Buswell Metal Products, Inc., Kensington, Conn. "On tough stainless steel ball races, for example, we've increased tool life from 5 to 8½ hours and we're getting excellent finishes with this outstanding cutting oil."

This is typical of reports from the scores of plants which have made some improvement in production or

tool life through the use of Gulf Electro Cutting Oil, the new sulphurized cutting oil that, because of greater sulphur activity, provides better protection for the tool.

Call in a Gulf Lubrication Engineer today and let him help you find opportunities for reducing machining costs through the use of one or more of the quality cutting oils in Gulf's complete line. Get in touch with your nearest Gulf office. Or send the coupon below for further information.



Gulf Oil Corporation · Gulf Refining Company MP  
719 Gulf Building, Pittsburgh 30, Pa.

Please send me, without obligation, a copy of your pamphlet  
"Gulf Electro Cutting Oil."

Name   
Company   
Title   
Address

## Tensile Strength of Warm Worked Austenitic Steel

(Continued from p. 168)

necessarily for the same condition of warm working. There was little significant difference to be found between tensile or creep properties obtained from pressing and from drop stamping.

**Production Warm Working**—Production warm working of disks of G18B was done on a 10-ton drop hammer at 1290° F., both in flat and contour dies. Although the process

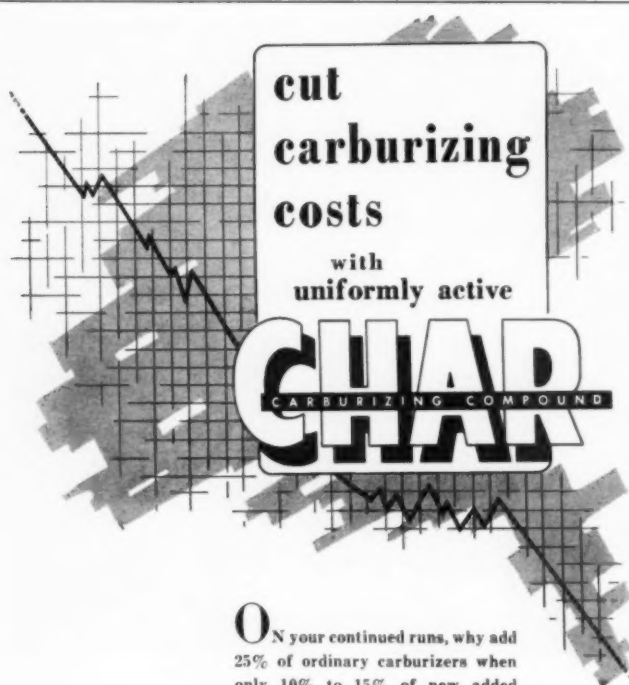
must be carefully controlled, it has given disks uniformly good properties and satisfactory performance under the most severe flight conditions. Room-temperature tensile ductility tended to be lower (8 to 15% elongation) at the disk center than at the rim (about 25% elongation). Tensile strengths were uniform throughout the disk, although not as high as those obtained on bar stock. This difference is dependent on the size of the disk and the capacity of the drop stamp.

Proof stress experiments with various size disks indicated that

there is little advantage in warm working a disk larger than 24 in. diameter and 5 in. thick with a 10-ton drop hammer. However, good proof stresses can be obtained at the center of larger disks by limiting the warm working area to only the center region of the disk. By determining the work affected zones from "iso-hardness" studies, tool designs and procedures involving two or three working stages were established for producing uniformly warm worked stub shaft disks. It was established that the beneficial effect of warm working on the creep strengths of disks was still in evidence after testing times of up to 10,000 hr.

Because of the excellent tensile properties obtained by warm working in tension, the difficult but probably practical procedure of imposing a radial tensile stress at the centers of large disks by hot spinning is considered a possibility for the future. Warm working should also be suitable on bar material for turbine blade production and for applications outside the gas-turbine field.

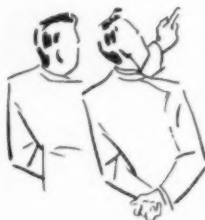
E. E. REYNOLDS



cut  
carburizing  
costs  
with  
uniformly active  
**CHAR**  
CARBURIZING COMPOUND

**O**N your continued runs, why add 25% of ordinary carburizers when only 10% to 15% of new added CHAR gives higher and more uniform activity.

The activated particles of CHAR are coated with a heavy shell of carbon, adding greatly to the mechanical strength of each particle. In addition, the coating prevents loss of energizing materials, saving you even more. Write today for interesting, cost-cutting CHAR booklet.



**CHAR PRODUCTS CO.**

MERCHANTS BANK BUILDING  
INDIANAPOLIS 4, INDIANA

## Welding Characteristics of Two Austenitic Steels Used for Gas-Turbine Rotors\*

INVESTIGATIONS have been carried out on the weldability, the weld metal characteristics, and the properties of welded joints, of two austenitic creep-resisting steels developed in Britain.

### ARC WELDING OF G18B STEEL

The austenitic steel G18B is a high carbon Cr-Ni-Co-Mo-W-Cb composition of lower alloy content than our American super alloys. A typical composition is 0.4 C, 14 Cr, 13 Ni, 11 Co, 1.5 Mo, 2.7 W, 2.6% Cb. In the as-cast state, G18B has better creep properties than in the wrought and heat treated condition, but with reduced ductility. For this research, special electrodes were developed, using G18B wire. The coating was of the usual silicate-bonded lime-fluorspar type, and contained suitable amounts of alloys to replace the losses which

(Continued on p. 172)

\*Abstract of "Weld-Metal Properties and Welding Characteristics of Two Austenitic Steels Used for Gas-Turbine Rotors", by E. Bishop and W. H. Bailey, Symposium on High-Temperature Steels and Alloys for Gas Turbines, Iron and Steel Institute, February 1951.

why it will  
pay you to  
**STOP**  
at booth G162

in the american gas ass'n section of the METAL SHOW

October 15 to 19 ... State Fair Grounds ... Detroit

**McKee  
Eclipse**

**benefit by the greatest selection**

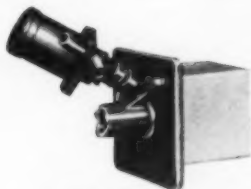
Eclipse offers the most complete line of Gas-Fired Industrial Heating Equipment on the market. This wide choice means we have exactly the right gas-heating unit for your particular application, or can design it for you.

**profit by Eclipse 43 Years' Experience**

Learn "What's New" by seeing McKee-Eclipse, one of the oldest Industrial Gas Appliance Designers and Builders; Pioneers since 1908, in originating and producing advanced designs for the industrial use of Gas. Let us apply our diversified experience to solving some of your gas-heating problems. Come in and visit with us at Booth G162, American Gas Ass'n Section.



McKee-Eclipse LOCK-TITE Safety Valve—heads a line of advanced Gas Heating controls.

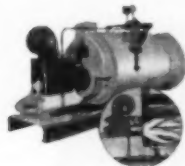


McKee-Eclipse Piloted Wall-Tite Burners—One of a complete range of Burners for every type of application.

**A few of the McKee-Eclipse Products:**



McKee Salt Pot Furnace—From an extensive selection of heat-treating and melting furnaces.



McKee Supermatic Scotch Steam-boilerplant—Typical of large line of Vertical or Horizontal Steam Boilers.

Ask for free  
new combustion  
equipment bulletin  
or refer to Sweet's  
Product Designers or  
Process Industries  
Catalog

Representatives in All Principal Cities

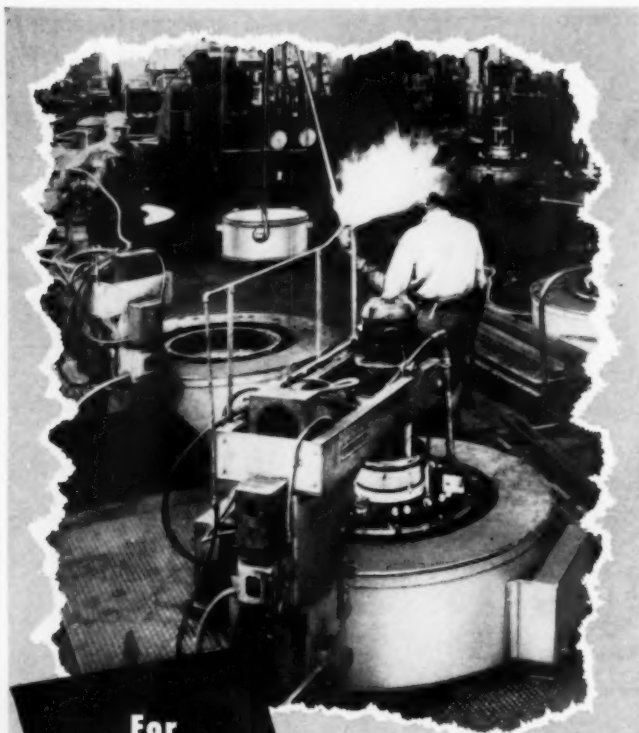
**Eclipse Fuel Engineering Company**  
727 South Main Street, Rockford, Illinois

**McKee  
Eclipse**

THE MOST COMPLETE LINE OF GAS-FIRED INDUSTRIAL EQUIPMENT ON THE MARKET

OCTOBER 1951; PAGE 171





For  
Accurate  
Case Depth  
and Carbon  
Control  
we rely on  
**HEVI DUTY**  
*Carburizing*  
**FURNACES**

says  
**Burgess Norton**  
MANUFACTURING CO.

• Burgess Norton uses 12 Hevi Duty vertical retort furnaces for carburizing piston pins to rigid case depth and carbon specifications. Metallurgical tests and quality control prove that each pin receives uniform heat treatment. These rugged furnaces operate 24 hours a day, six days a week with minimum down time.

Learn how dependable Hevi Duty vertical retort furnaces provide accurate heat treatment on a production basis. Write for your copy of bulletin HD-646 — today.

See the Hevi Duty Vertical Retort Furnace Booth D-350 at the Metal Show

**HEVI DUTY ELECTRIC COMPANY**

HEAT TREATING FURNACES **HEVI DUTY** ELECTRIC EXCLUSIVELY  
DRY TYPE TRANSFORMERS — CONSTANT CURRENT REGULATORS  
MILWAUKEE 1, WISCONSIN

## Welding Characteristics of Two Austenitic Steels

(Continued from p. 170)

occur in the welding arc. The only modifications were a slight drop in carbon and an increase in tungsten.

The electrodes were subjected to extensive usability tests, including restrained butt-welds. No tendency to crack formation was ever observed.

The microstructure of G18B plate material consists of fine carbide particles in an austenitic matrix; the weld metal has a fine dendritic structure. No traces of ferromagnetism have ever been detected in this weld metal ( $\mu < 1.1$ ), so that the interdendritic material must consist of carbides, intermetallic compounds, and austenite of a composition slightly different from that of the matrix.

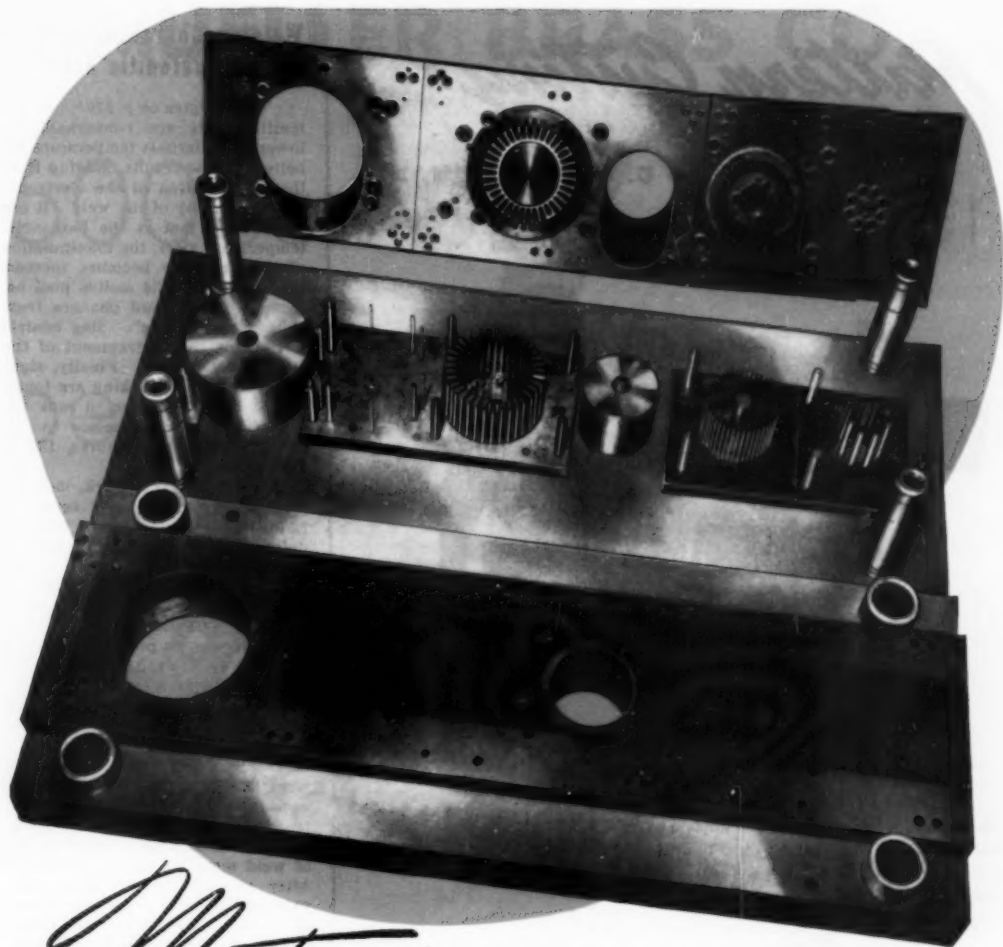
Mechanical properties of the weld metal were obtained on all-weld-metal samples. Specimens were tested in the as-welded condition, after stress-relieving for 1 hr. at 1200° F., and after solution treatment at 2400° F. In the as-welded condition a very good combination of properties was obtained (100,000 psi. ultimate tensile strength, 15% elongation in 2 in., 25% reduction in area, 17 ft.-lb. Izod). Because the weld metal had better properties in the as-welded state, solution treatment was unnecessary.

Two types of arc welded butt joints were studied, one a 60° included angle "V" joint, the other a 15° included angle "U" joint. The root radius of the U was  $\frac{1}{4}$ -in., with root face of  $\frac{1}{8}$  in., and a root gap of  $\frac{1}{16}$  in. The arc welding was carried out as usually recommended for austenitic electrodes. "Weaving" was strictly avoided. Separate experiments using a wide weaving technique showed no apparent ill effects; however, this was considered poor practice and was not recommended, because it also introduced some difficulty in slag control.

The slag was very carefully removed between passes. After chipping and brushing, the weld surface was examined with a lens, and all traces of slag were removed. This was very time-consuming, and the average cleaning operation took six to eight times as long as did the actual welding.

The authors comment on the effects of preheating and of using high interpass temperatures. From their experience, as far as aus-

(Continued on p. 174)



## *Masterpiece* by CROMOVAN

100,000 pieces per grind . . . 100% increase in production over former dies . . . is the outstanding performance of this Cromovan six station, progressive lamination die. The die punches out both rotor and stator laminations complete . . . from .025 silicon lamination sheets . . . clearance tolerance of .0007 inch per side is strictly maintained between punches and die. All cutting surfaces of this die are made of CROMOVAN.

R248

**VISIT OUR BOOTH G-446  
AT THE A.S.M. SHOW**

SEE THE NEW METHOD-X MACHINING  
SINTERED CARBIDES, SUPERALLOYS  
AND OTHER "NON-MACHINABLE" METALS.

## *Firth-Sterling*

**STEEL & CARBIDE CORPORATION**

General Offices: 1330 Forbes St., Pittsburgh, Pa.

OFFICES: NEW YORK • HARTFORD • PHILADELPHIA • PITTSBURGH • CLEVELAND • DAYTON • DETROIT • CHICAGO • LOS ANGELES

# Pattern Cutting

by G. O. CARLSON, INC.

*Saves* TIME



*Saves* STAINLESS

This order for stainless plate was shipped by G. O. Carlson, Inc. "cut ready to finish," and it is typical of a great number of such jobs which we are regularly producing for critical applications.

The Carlson service in stainless steels begins with the plate itself, produced to chemical industry standards of quality. In addition, we have available our specialized facilities for laying out and pattern cutting plate to specifications.

This combination is making it possible for us to conserve vitally needed material in many cases—since it allows us to make best use of available stock with minimum scrap loss . . . and the customer receives his plate ready for final finishing prior to fabrication.

*Stainless Steel is our only business . . . and we know it.*

G.O.

## CARLSON, INC.

Stainless Steels Exclusively  
300 Marshallon Road, Thorndale, Pa.

PLATES • FORGINGS • BILLETS • BARS • SHEETS (No. 1 Finish)  
District Sales Offices and Warehouse Distributors in Principal Cities

## Welding Characteristics of Two Austenitic Steels

(Begins on p. 170)

tenitic steels are concerned, the lower the interpass temperature the better are the results, judging from the manipulation of the electrodes and the quality of the weld. It has been found that as the base-metal temperature rises, the manipulation of the electrode becomes increasingly difficult. The molten pool becomes enlarged and changes from "quiet" to "boiling". Slag control is difficult, and entrapment of the slag occurs readily. Finally, signs of porosity and cracking are found in the crater. Hence, it was the authors' standard practice to use low interpass temperatures, 120 to 140° F. maximum.

Throughout the work, no test plate was rejected as a result of radiographic examination, and no defects were observed, with the exception of occasional slight porosity at the extreme ends, where it was impossible to avoid superimposing a number of craters.

There was no point of superiority for either the "U" or the "V"-type joints when all the data were considered. In the as-welded condition it would appear that the "V"-type weld was more ductile, inasmuch as the bend specimens were bent to a greater angle. The difference was not apparent in the tensile tests, because the gage length included an average of about ½ in. of weld metal and 1 ½ in. of plate. After stress-relieving, and more particularly after solution treatment, there was no marked difference between the two types of joint. Possibly the slight difference in the as-welded condition was due to the different systems of residual stresses in the two types of joint. Stress-relieving, as expected, had very little effect on the mechanical properties of the welded joints, and it was questionable whether the residual stresses were in fact removed by this treatment. The data were reported to show that welded joints suffered no ill effects on heating to medium temperatures.

All creep tests were carried out at 1290° F., which is a normal operating temperature for G18B. The minimum creep rate, rupture time, and elongation at rupture, showed close agreement between the results on "U" and "V" joints. It was concluded that there was no difference in creep strength between "U" and "V" joint welds for G18B in the

(Continued on p. 176)

# MUELLER BRASS CO.

600 series  a better  
bearing bronze  
 containing no  
hard-to-get tin  


If you use gears, connecting rods or other parts of bearing metal in your products, it will pay you to investigate Mueller Brass Co. "600" series, a forgeable bronze that contains no critical tin. This bearing metal outperforms phosphor bronze and other bearing metals and will save you money in your applications. "600" series bearing metal can be forged into relatively complicated shapes and produces a forging of close-grained homogeneous structure impossible to get in a casting. The forged shape is closer to finished size than a casting and requires less machining. "600" series alloys have a low coefficient of friction, a tensile strength  $2\frac{1}{2}$  times greater than cast phosphor bronzes and a high resistance to corrosion. "600" has a 25 year record of outstanding performance on some of the toughest bearing applications. There is a "600" series alloy with the properties to fit your bearing metal needs . . . write today for further facts.

*Four typical parts forged from Mueller Brass Co. "600" series Bearing Bronze.*

**MUELLER BRASS CO.**

PORT HURON 15, MICHIGAN

44

OCTOBER 1951; PAGE 175



## "REJECTS CAN BE MINIMIZED WITH THE RIGHT CUTTING FLUID"

**T**HERE is always one *right* cutting fluid for every machining job—one that will do the job better or faster, or both. Take Rudolph's problem of *rejects*. Here is what one company did about it.

**THE OPERATION.** Grinding the bearing surface and shoulder on engine camshafts of RC60 hardness.

**MACHINES AND WHEELS.** Camshaft Grinders with 80 grit wheels.

**STOCK REMOVAL.** Remove .036" on bearing surface and .012" to .020" on side of shoulder.

**PREVIOUS RESULTS.** Wheel face dressed after 8 pieces, wheel sides after 3 pieces. *Scrap loss 18%.*

**WITH STUART GRINDING OIL.** Wheels dressed on face and sides after 18 pieces. *No scrap loss.*

You can secure benefits like this. Ask to have a Stuart Representative call.

*Are you receiving Stuart's Shop Notebook regularly?*

**CONSERVE  
CRITICAL  
MATERIALS**

**Use the  
RIGHT  
Cutting Fluid**

**Metal Show  
Detroit  
Oct. 15-19  
Visit  
STUART BOOTH  
No. A-266**

**D.A. Stuart Oil co.**  
EST. 1865 LIMITED

2743 South Troy Street, Chicago 23, Illinois

METAL PROGRESS; PAGE 176

## Welding Characteristics of Two Austenitic Steels

(Begins on p. 170)

as-welded condition at 1290° F. Furthermore, at this temperature the creep strength of the actual welds was approximately 20 to 30% higher than that of solution treated wrought material. This higher strength was more evident when the rate of creep rather than the time-to-rupture was considered, but the ductility of the weld metal was rather lower than that of the parent material.

Two series of tests of the effect of heat treatment after welding were made: (a) on welds solution treated at 2400° F. (the standard heat treatment for G18B), and (b) on welds stress-relieved at 1200° F. after welding. Within the limits of material uniformity and experimental technique, both the solution treated and the stress-relieved G18B welds had a creep strength at 1290° F. equal to that of standard material (minimum creep rate 10<sup>-5</sup> in. per in. per hr. at 22,000 psi.).

### ARC WELDING OF R20 STEEL

Austenitic R20 steel has a chemical composition resembling the American Type 347, with high nickel and carbon. A typical composition is 0.14 C, 19 Cr, 14 Ni, 1.5% Cb. Two electrodes were studied: R20 wire specially coated with a flux very similar to that used on G18B, to give weld metal of unchanged composition; and a proprietary electrode, giving a very similar type of weld metal.

The tensile and Izod impact test results on all-weld-metal specimens made from the two electrodes showed defective weld metal in the case of the proprietary electrode, the appearance of the fracture being oxidized. The unsatisfactory properties of the proprietary weld deposits were traced to numerous microcracks. These always occurred in multipass deposits, but could seldom be seen in single-pass welds.

The problem of microcracking has been studied very extensively in America (reference is made to seven papers in *The Welding Journal* and *Metal Progress*, but no completely satisfactory explanation has yet been given. Much investigation has been carried out by the authors into the causes and prevention of microcracking in fully austenite weld metals, and this work will be

(Continued on p. 178)



# Aluminum

Government regulations limit the use of aluminum for other than essential projects. The facts presented here are to help you speed this essential work and get the most out of available metal.

Many will be working with it in new forms as they help America rearm. Here Alcoa presents useful information on the latest methods of Fabrication and Design Techniques.

## CONTENTS

Aluminum Impact  
Extrusions

Magnesium

Aluminum Die Castings

Finishing Aluminum

Aluminum Castings

Aluminum Fasteners

Aluminum Screw

Machine Stock

Aluminum Extrusions

Various aluminum impact extrusions showing interesting design possibilities such as internal and external projections, heavy sections, thick bottoms combined with thin walls and large over-all size.



## Aluminum Impact Extrusions

The trend is to larger, more complicated parts having better finish and closer tolerances. New Alcoa developments offer designers interesting possibilities.

**High Strength.** An increasing proportion of impact extruded shells is being produced in tough, heat treated alloys. In addition to the medium strength alloys, considerable success has been attained with the high strength alloys 14S and 75S with tensile strengths of 70,000 psi or greater.

**Stepped Extrusions.** Utilizing the stepped extrusion principle it is possible, within certain limits, to step out the open end portion of a shell to a larger diameter. This is accomplished during extrusion without the necessity of a secondary expanding operation.

**Multiple Wall Extrusions.** Extruded shells with a centrally located internal hollow tube integral with the bottom and side wall are now being produced on a production basis. Alcoa will welcome the opportunity of working with design engineers to develop shells with one or more integral internal tubes.

**Lateral Extrusions.** A new development in the impact extrusion art is extrusion in a lateral direction. Articles

having a central hub section can be made with arms or spokes of various cross sectional shapes. The lengths of the arms or spokes depend upon the intricacy of the article's design.

**Solid Shapes.** Many designers consider impact extrusions only for hollow, cylindrical or cup-shaped parts. Actually, Alcoa produces many solid and semi-solid impacts as well. These are also available in the tough, heat-treatable alloys, and are used as blanks for subsequent machining operations; in some cases it is possible to eliminate machining entirely. Often the saving in scrap loss more than offsets the slightly higher cost compared to bar stock.

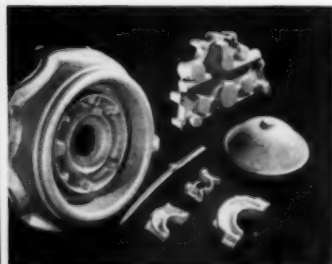
Alcoa has limited impact extrusion capacity available to manufacturers with authorized production schedules and metal allotments. All designers should have a copy of the free, 43-page handbook, "Alcoa Aluminum Impact Extrusions."



ALUMINUM COMPANY OF AMERICA • 1805K GULF BLDG., PITTSBURGH, PA.

# Magnesium

The same Alcoa facilities that cast, forge and extrude aluminum are also equipped for similar operations in magnesium.



## FORGINGS

Although not as strong as aluminum forgings, magnesium is used where weight saving is of vital importance. Sometimes a limit is reached in reducing sections of aluminum forgings to cut weight. Direct substitution of magnesium for aluminum results in a one-third weight saving.

## EXTRUDED SHAPES

The cross sections of magnesium extrusions may often be designed to obtain the stiffness and strength of steel with the lightness of wood. Magnesium extruded shapes combine maximum structural efficiency with minimum weight and cost.

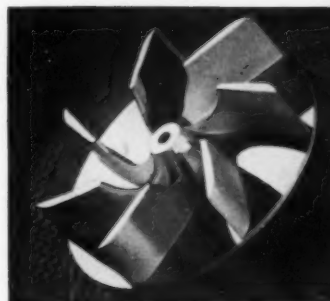


## DIE CASTINGS

Magnesium may be cast with nearly the same close dimensional tolerances and standards of draft as zinc die castings. It machines faster than any of the die casting metals. Its lighter weight makes the cost per casting extremely attractive.

## CASTINGS

Both sand and permanent mold castings of magnesium are produced by Alcoa foundries. Frequently, magnesium castings are used to replace riveted aluminum assemblies. Although weight is not always reduced, the change simplifies construction and reduces labor cost. Magnesium castings often compete with cast iron in price.



# Aluminum Die Castings

Careful choice of a supplier is an important step in guaranteeing the performance that the engineer designs into a part. Consider the facilities of Alcoa's two modern plants.

## Location

Plants at Garwood, New Jersey and Chicago, Illinois are strategically located to serve the heart of the metal-working industry. Shipping time is short and expenses are low. Close liaison with the plants is possible.

## Experience

Alcoa Die Castings are backed by 36 years of continuous operation — 63 years of aluminum experience. Alcoa casts only aluminum and magnesium. Machines,

toolroom facilities and metallurgical laboratories are highly specialized for light metal castings — personnel are "old hands" at working with aluminum and magnesium.

## Design Help

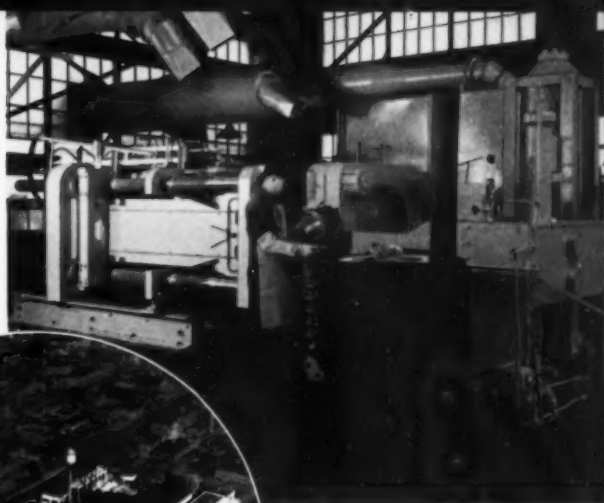
Each of the Alcoa district sales offices has a sales engineer who is ready to serve you. He is instantly available for design consultation, and will efficiently interpret your design and production requirements to Alcoa's large staff of die casting specialists at either plant.



ALUMINUM COMPANY OF AMERICA • 1805K GULF BLDG., PITTSBURGH, PA.

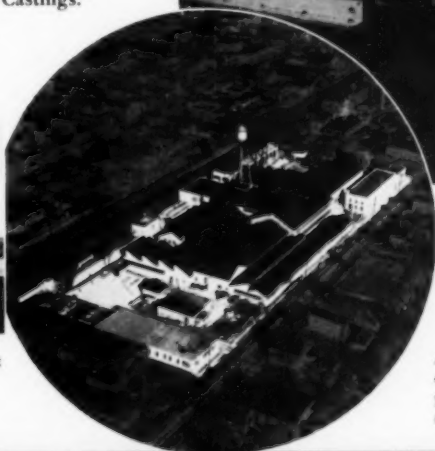
### Capacity

You can depend on, and schedule your production to Alcoa quotations and delivery promises. Alcoa has open capacity available to manufacturers with authorized production schedules and metal allotments. Your local Alcoa sales office, listed under "aluminum" in the classified phone book, will supply prompt quotations. Write for a free copy of the 188-page designers' handbook, "Designing for Alcoa Die Castings."



Typical of the large die casting machines specially designed by Alcoa for use in our two modern plants.

Alcoa's new die casting plant at Chicago, Illinois.



Alcoa's Garwood, N. J. die casting plant — established 29 years — recently expanded and modernized.

## Finishing Aluminum

**Paint finishes offer pleasing decorative effects and excellent protection at extremely low cost. Simple procedures guarantee good results.**



Baked-on enamel finish applied to spotting scope made of aluminum.

**Cleaning.** The simplest, but least effective method is to wipe with cloths or brushes saturated with mineral spirits. More effective methods are solvent vapor degreasing, solvent emulsion or inhibited alkaline cleaning. Chemical or electrochemical treatments used in conjunction with suitable cleaning methods are recommended for severe exposure conditions.

**Priming.** Primers should resist moisture penetration, adhere well, form a good base for second coats and should contain an inhibitive pigment. Primers containing zinc chromate have all these properties. In many cases, aluminum pigmented primers are very satisfactory. Wash coat primers produce excellent results. The use of lead pigments should be avoided.

**Finishing Coats.** Any durable paint, enamel or lacquer may be sprayed, brushed or dip-coated on aluminum once it is suitably primed. In using lacquer, the primer coat must be compatible with the lacquer finishing coats. Bituminous paints, used to protect aluminum from alkalis, should be applied over a primer of the type.

Complete information on painting as well as plating, and finishing by chemical, electrochemical and mechanical methods is available at your local Alcoa sales office.



Aluminum seals with enamel finishes.



**ALUMINUM COMPANY OF AMERICA • 1805K GULF BLDG., PITTSBURGH, PA.**

# Aluminum Castings

**There's a lot more to the final cost of castings than the price a foundry quotes you.**

The price from the foundry is one thing. The final cost . . . machined, handled, assembled into place, and properly finished as part of your completed product can be quite different.

An aluminum casting made by Alcoa might seem to cost a little more than one of another metal as quoted by the foundry. But what machining is needed can be done at speeds impossible with most heavier metals. As a matter of fact, few machine tools can exceed the speeds at which aluminum can be machined.

Aluminum castings can usually be moved quickly by hand. Similar castings of heavy metals would weigh up to three times as much and would usually require hoists. Assembly of aluminum castings is faster . . . painting is frequently eliminated.

**And once you've decided on aluminum castings, what about a supplier?**

The wrong alloy can affect performance of the part, or add to the cost of casting. A supplier, like Alcoa, experienced in creating aluminum casting alloys, can give you reliable counsel on alloy selection. A supplier, like Alcoa, can get together with your designers on details of design that can have major bearing on final cost and performance. Further, a supplier with Alcoa's flexibility and high capacity can set up delivery schedules that you can depend on . . . that can set a fast pace for your own production line.

Alcoa has casting capacity available to manufacturers



**Even large aluminum castings can be quickly moved by hand, are easily machined, require no painting in most cases.**

with authorized production schedules and metal allotments. Your local Alcoa sales office, listed under "aluminum" in the yellow phone book, will gladly help you.

# Aluminum Fasteners

**As aluminum is designed into defense equipment, proper selection of rivets becomes increasingly important. Here Alcoa presents facts on Alloys, Temperatures and Driving Procedures.**

## **Alloy 2S-F**

These rivets are relatively soft, are always driven cold. If maximum softness is desired, 2S-O alloy may be used.

## **Alloy A17S-T4**

Furnished in the heat treated condition and are driven cold as received. Not quite as strong as 17S-T4 rivets,

but they eliminate reheat treatment and cold storage necessary on many sizes of 17S-T4 rivets.

## **Alloy 17S-T4**

Usually furnished in heat treated condition. Small sizes may be driven cold. Larger sizes require reheat treatment and cold storage unless driven within a few hours after treatment.



**ALUMINUM COMPANY OF AMERICA • 1805K GULF BLDG., PITTSBURGH, PA.**

#### 24S-T4

Strongest and most difficult to drive of the aluminum rivets. Generally used only in smaller sizes. They are supplied heat treated, but require reheat and cold storage.

#### 53S-T61

Supplied in heat treated condition and are driven cold as received. They have stable mechanical properties, may be stored indefinitely. 53S-T6 alloy is slightly stronger, but requires more driving pressure.

#### 56S-H32

Good strength, good driving characteristics. They are supplied in the cold-worked temper and are driven as received. Used extensively for magnesium work.

#### Hot Driving

17S-T4 and 43S-T4 alloys may be hot driven in the larger sizes. They are quenched sufficiently by driving immediately upon removal from the furnace. Their properties are developed by natural aging after driving.

*Write for the free, 61-page book,  
"Riveting Alcoa Aluminum"*



Alcoa Distributors and Jobbers stock a wide range of rivets in standard alloys and sizes. Special rivets are available on order.

## Aluminum Screw Machine Stock

**Most design requirements can be satisfied by one of the free-cutting alloys which vary widely in physical and mechanical properties.**

Before the cost advantages of Alcoa Screw Machine Stock comes consideration of performance.

What are the strength requirements? Alcoa Screw Machine Stock Alloys range in tensile strength from 42,000 to 62,000 psi. Elongation varies from 10 to 16 per cent in four diameters. Must the part conduct electricity or heat? The free-cutting alloys average between 30 and 40 per cent of the International Annealed Copper Standard on an equal volume basis. They provide thermal conductivity ranging from 0.29 to 0.37 C.G.S. units at 25° C. Their approximate melting

temperatures vary between 995 and 1205° F.

Alcoa Alloys resist corrosion by weather, industrial fumes and hundreds of hard to handle chemicals. At sub-zero temperatures they actually *increase* in tensile and yield strengths.

These are but a few of the interesting properties which merit your serious consideration when the free-cutting alloys are again available for unlimited use. Meanwhile, write for a free copy of the 178-page book, "Alcoa Aluminum and Its Alloys."

**MECHANICAL PROPERTIES OF THE FREE-CUTTING ALLOYS**

ALLOY	THICKNESS INCHES	TENSILE STRENGTH LBS./SQ. IN.	YIELD STRENGTH LBS./SQ. IN.	ELONGATION, % IN 4 DIA., MIN.
11S-T3	0.125 to 1.5	45,000	38,000	10
17S-T4	0.125 to 8.0	55,000	32,000	16
24S-T4	0.125 to 5.5	62,000	40,000	14
61S-T6	0.125 to 8.0	42,000	35,000	10



**ALUMINUM COMPANY OF AMERICA • 1805K GULF BLDG., PITTSBURGH, PA.**



# Aluminum Extrusions

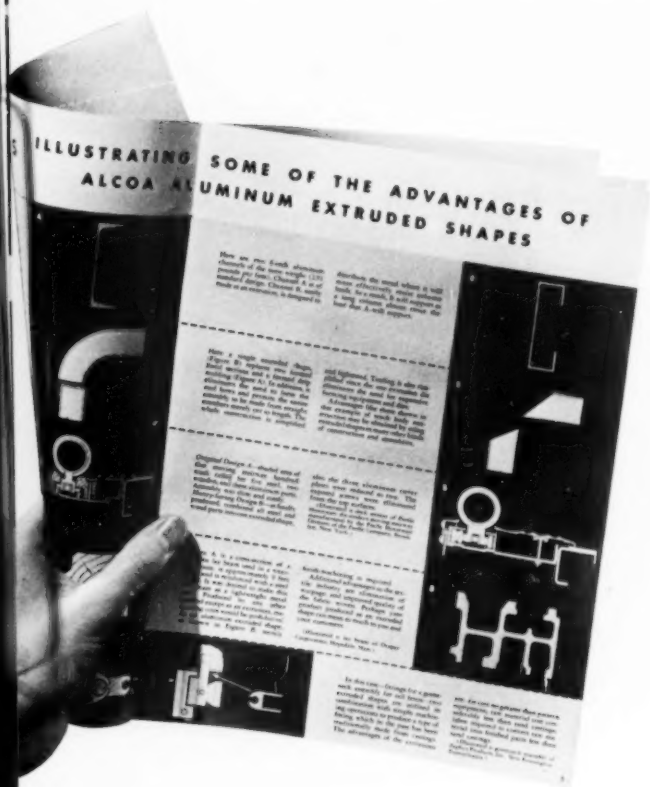
Almost any shape can be produced by Alcoa. Hollow, semi-hollow, solid . . . any form (within a 15-inch circumscribing circle diameter).

The biggest advantage of aluminum extrusions, made by Alcoa, is that they permit placement of the metal where good design calls for it. Put it where stresses are greatest and where maximum strength is needed, yet save metal as compared to roll forming or fabricating an equivalent section.

To help you visualize the almost limitless possibilities of aluminum extrusions, and to suggest ways in which you can adapt your designs to them, Alcoa has prepared a special booklet that's yours for the asking. Write for it today on your company letterhead. Ask for "Alcoa Aluminum Extruded Shapes."

## Here's what the booklet contains:

- a discussion of design and production advantages of aluminum extrusions
- examples of aluminum extrusions that have increased strength and stiffness because of efficient metal distribution
- examples of designs that have been simplified by the use of a single extruded shape to replace expensive built-up assemblies, castings, or machining
- illustrations of the way several extruded shapes can be combined to simplify assembly and reduce costs
- data on size and shape limitations, alloys, section thicknesses, tolerances, die costs
- suggestions on modifying designs to utilize standard shapes for which dies already exist



ALUMINUM COMPANY OF AMERICA • 1805K GULF BLDG., PITTSBURGH, PA.

# WHEREVER THE HOT STUFF HITS USE NATIONAL CARBON

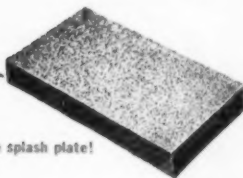
TRADE-MARK



For the cinder notch liner!



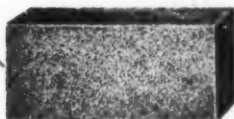
For the cinder notch plug!



For the splash plate!



For the runout troughs!



For the skimmer plate!

● "National" carbon is now firmly established for blast furnace linings. It is being used outside the furnace as well—wherever there is contact with molten material—for the splash plate, runout troughs—clear down to the ladle—skimmer plate, cinder notch liner and cinder notch plug.

The reasons?

"National" carbon has no melting point. It is highly resistant to slag attack and thermal shock... not wet by molten metal... has a low thermal expansion... and maintains its mechanical strength at elevated temperatures.

Use "National" carbon inside and outside your blast furnaces and you cut down maintenance, speed up production and save money. For more information, write to National Carbon Company, Dept. M.

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

**NATIONAL CARBON COMPANY**

A Division of Union Carbide and Carbon Corporation  
30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

IN CANADA: National Carbon Limited  
Montreal, Toronto, Winnipeg

A COMPLETE LINE OF



## PRECISION INSTRUMENTS

### for Metallographers

#### NEW DESK-TYPE METALLOGRAPH

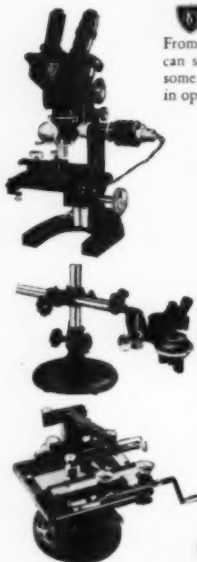
Years ahead in simplicity and ease of operation. Perform every operation while sitting comfortably at a modern desk... compose the picture on a screen directly in front of you... focus camera automatically while examining specimen through the microscope... take notes, change magnification, adjust the lamp, make the exposure—all with unbelievable speed, ease, and precision. Other features: monocular or binocular bodies, revolving objective turret, two lamps—visual and photographic, "autofocus" coarse adjustment stop.



#### SPENCER METALLURGICAL MICROSCOPES

From this complete line of Spencer Metallurgical Microscopes you can select an instrument that exactly meets your needs. Here are some of the many outstanding features for convenience and speed in operation:

- **Americote Optics** eliminate reflections and provide added contrast.
- **Wide Range Adjustable Stage** handles unusually large or small specimens.
- **Large, Sturdy, Research-Type Stand** with micrometer screw fine adjustment... interchangeable body tubes.
- **Brilliant, Uniform Illumination** from a vertical illuminator that is simple to operate, sturdy, and always cool enough to handle.
- **Variety of Equipment** for teaching, routine examinations, and research.



#### SPENCER STEREOSCOPIC MICROSCOPES

Two distinct advantages are offered by these instruments:

1. The image is erect and a wide field of view is provided.
2. The image has depth and shows the specimen in three-dimensional perspective.

These are real advantages in studying surface characteristics and examining parts.

No. 26 is designed for examining small specimens.

No. 23 (illustrated) for large objects. No. 353 lamp provides an adaptable source of illumination.



#### SPENCER BIERBAUM MICROCHARACTER

This is a precision instrument for determining the hardness of small areas, particles, and microscopic constituents in metals. A highly polished and lubricated specimen is moved by micrometer feed beneath an accurately ground diamond point. The pressure is precisely controlled so that hardness can be determined by the width of the resulting cut when measured under the microscope.

For further information about these and other Spencer Instruments write Dept. X119.

American  Optical

COMPANY

INSTRUMENT DIVISION • BUFFALO 15, NEW YORK

## Welding Characteristics of Two Austenitic Steels

(Begins on p. 170)

described in a future paper. Briefly, cracking occurs under the following conditions:

1. The absence of delta-ferrite in the structure.
2. The simultaneous presence of silicon in amounts exceeding about 0.40% and of columbium in excess of about eight times the carbon content.
3. Reheating of the metal to high temperatures (for example, by the deposition of later passes of weld metal). Thus, if an austenitic alloy containing silicon and excess columbium is heated within the range between about 1200° F. and its melting point, a characteristic grain-boundary precipitate is formed. Positive X-ray identification of the precipitate as a complex Fe-Cb-Si compound has been obtained, and it has been found that this structure normally occurs in austenitic steels under conditions cited in 1 and 2, but that it only leads to cracking when delta-ferrite is absent. The latter constituent, which also occurs at the grain boundaries of the austenite, inhibits the formation of cracks.

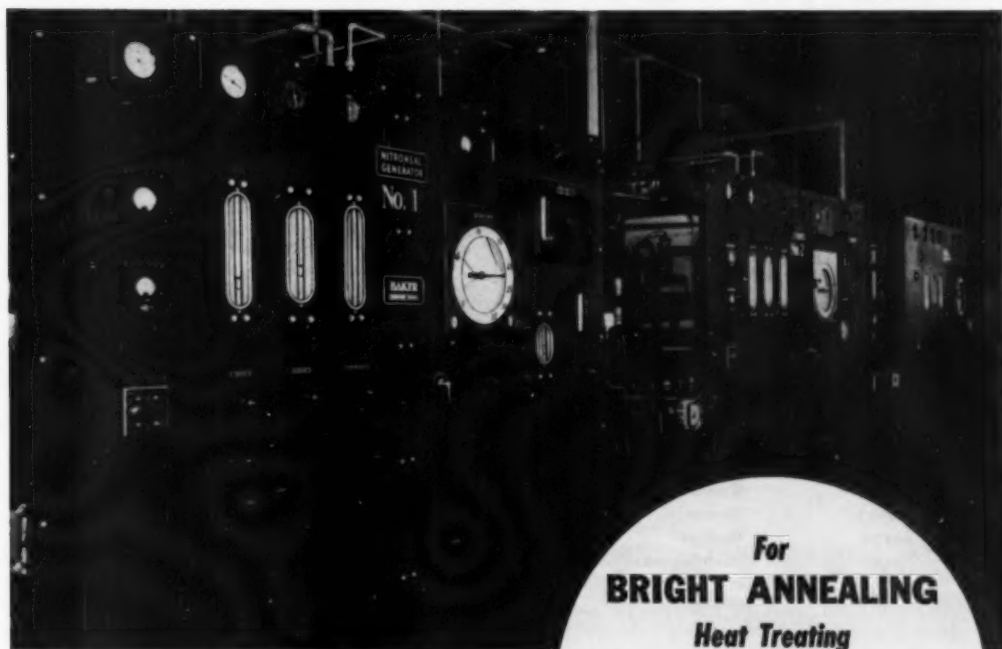
Accordingly, further electrodes were developed in which the silicon content and the columbium-carbon ratio of the weld metal were closely controlled. A tentative specification was drawn up to cover the weld metal composition deposited by electrodes for use in welding R20 steel forgings, as follows: C 0.12 to 0.16, Mn 0.7 to 1.5, Si 0.30 max., S 0.030 max., P 0.030 max., Cr 13.0 to 15.0, Ni 18.0 to 20.0, Cb 8 to 10 times carbon content.

Primary factor is rigid control of the silicon content. If this is kept below 0.30%, the permissible columbium limit may probably be raised, whereas with higher silicon contents, cracks may occasionally occur with quite low columbium-carbon ratios. On the other hand, the columbium-carbon ratio must remain adequate to prevent weld decay. To assist electrode manufacturers, it will be necessary, the authors say, to provide special heats of R20 steel for wire production, having a maximum limit of 0.20% of silicon.

All-weld-metal bars were tested in the as-welded condition, after stress-relieving for 1 hr. at 1200° F., and after normalizing at 2000° F., and a series of "U" and "V" butt

(Continued on p. 180)

# NITRONEAL GAS



Typical Steel Mill Application of Three Model 3000-G Nitronal Generators

**SEE UNIT ON DISPLAY AT  
METAL SHOW DETROIT OCT. 15-19**

## NITRONEAL GENERATORS

Available in 100 C.F.H. to 10,000 C.F.H. Capacities

Fundamentally new ammonia-air reactor produces pure nitrogen with a controllable hydrogen content that can be varied at will and maintained at any percentage from .25% to 30% as required.

- FULLY AUTOMATIC
- NO OPERATING PERSONNEL REQUIRED
- NO EXPLOSION HAZARD
- 30% LESS COSTLY THAN DISSOCIATED AMMONIA

GAS RATIOS PER 1000 CUBIC FEET OF FINISHED NITRONEAL GAS

% HYDROGEN	.25	1.0	3.0	6.0	20.0	25.0	30.0
AMMONIA (c.f.)	301	304	309.3	316.7	350	370	386
AIR (c.f.)	1070	1064	1033	990	790	715	640

*Baker & Co., Inc.* 113 ASTOR ST., NEWARK 5, N. J.

# METAL POWDERS ESSENTIAL TO MODERN MILITARY PRODUCTS



**Tanks  
Planes  
Trucks  
Jeeps  
Ships**



**Guns  
Radar  
Sonar  
Radios  
Telephones**



**Missiles  
Bombs  
Shells  
Incendiaries  
Smoke Screens**

The items listed above are materiel of modern defense—without them a nation would be largely dependent upon swords and spears; cutlasses and battle-axes; bows and arrows; horses, mules and carrier pigeons.

*Are you aware of the part metal powders are playing in the Defense Program?*

Without iron and other metal powders, the production of all of these items listed—and many others—would suffer seriously from the standpoint of quality of product, or rate of output, or cost to produce.

*Are you taking advantage of the cost reductions, the conservation of critical materials, the time savings and other advantages that are possible through the use of powder metallurgy?*

**PLASTIC METALS** is one of the leading metal powder producers in the world. Over 17 years of experience in this field is at your disposal.

*For more detailed information, write to*



## Welding Characteristics of Two Austenitic Steels

(Begins on p. 170)

welds in 1-in. thick R20 plates were tested. Preheating was avoided and low interpass temperatures were used. The finished welds were machined and radiographed. Again, the standard achieved was very high and no defects were observed, except for occasional porosity at the extreme ends. Full solution treatment was inapplicable, as it would rarely be carried out on welded assemblies. These welded specimens were extremely satisfactory. The weld metal closely matched the parent plate in chemical composition; it had excellent mechanical properties (85,000 psi. ultimate tensile strength, 30% elongation in 2 in., 60% reduction in area, 40 to 50 ft.-lb. Izod), and was very sound and free from defects.

Creep tests on R20 welds were carried out at 1200° F., which is a reasonable operating temperature for this material. The strength of the actual weld deposit (that is, virtually as-cast material) was apparently very similar to that of the parent metal, since in these tests there was no discrepancy between results on large and small specimens. This was further confirmed by the fact that some of the tests fractured in the weld and others in the parent metal, whereas with the G18B steel all the fractures occurred in the parent metal.

Duplicate tests were made to check the relative advantages of "U" and "V" joint welds, and samples were tested in the as-welded condition and also after normalizing from 2000° F. In general, the agreement was good between the two types of weld, so that no distinction needed to be made between the two. On the basis of rupture strength (500 hr. to rupture at 22,000 psi.), the R20 welds were very similar to standard material; they were a little stronger on the basis of creep strength. It was therefore evident that, as with G18B, the welding of R20 did not markedly affect its creep strength, and welds could be put into service without heat treatment after welding. While the effect of a low-temperature stress-relieving treatment was not investigated, it was thought that this would not produce any marked change in the creep strength, since it is merely equivalent to a very short time at service temperature without an applied stress.

(Continued on p. 182)





# Enthone products for better Pickling of steel -

FOAM BLANKET FORMED BY  
ACID ADDITION AGENT  
TRAPS ACID FUMES

## ACID ADDITION AGENT

Stops fuming of acids — promotes better wetting — lowers drag-out — saves acid — less harm to operator — less corrosion on surrounding equipment — more uniform pickling effective with sulphuric acid hot and cold — hydrochloric — phosphoric — hydrofluoric acids.

## COMPOUND 42

A new cleaning and pickling agent combined—removes oil and rust at room temperature in One operation — prepares metals for painting — inhibits rusting — apply by dipping or brushing.

## INHIBITOR 8

A new complete inhibitor to stop attack on base steel — high inhibition in sulphuric—hydrochloric—phosphoric acids — lowers surface tension — less drag-out — saves acid—reduces rusting after pickling — reduces fuming — bright pickling — makes pickling a more pleasant and healthful operation.

## COMPOUND NR-37

Prevents rusting during drying but leaves no residue — added to hot or cold water it permits drying without rusting and leaves steel clean for painting — very effective for porous castings.

# ENTHONE

INCORPORATED

Write for Check List  
Sixty Products and Processes  
for Metal Finishing

442 ELM STREET • NEW HAVEN, CONNECTICUT

300% to 400% (even 1000%)  
**Now faster Research and  
 Production Control  
 analyses**



Exceptional speed of  
 Jaco Spectrographic  
 equipment allows  
 laboratory to keep  
 pace with production  
 or process speed

Experience . . . in chemical process plants . . . in metals industries . . . in research laboratories . . . proves that the complete Jaco Spectrographic Laboratory does analyses in one day that would ordinarily require three or four days by other methods. You can actually make a complete quantitative analysis for six or seven constituents in less than fifteen minutes. Or, if results for a single sample are not needed so quickly, you can make several exposures on each photographic plate and cut analysis time per sample even more.

But there's more to the story than speed — Jaco Spectrographic Equipment is as precise as it is fast. Overall accuracy of  $\pm 3\%$  of amount present is possible, and in low percentage problems as little as 0.001% and even less of trace elements are easily determined quantitatively (0.0006% Boron in steel, for example).

These are only a few of the many advantages that are yours with Jaco Spectrographic Equipment. Find out more by writing for all the details today.

**JACO**

Projection comparator  
**MICROPHOTOMETER**

Designed especially by Jaco for your most exacting requirements. Measures spectrum line transmissions quickly and precisely (five or more lines a minute).



**JARRELL-ASH**

Company

165 Newbury Street, Boston 16, Mass.  
 Visit Booth B111, National Metal Congress,  
 Detroit, October 15 to 19

METAL PROGRESS; PAGE 182

**Welding Characteristics of  
 Two Austenitic Steels**

(Begins on p. 170)

**WELDING OF ROTOR ASSEMBLIES**

To the best knowledge of the authors, the Swiss firm of Sulzer Brothers, Winterthur, have made the greatest advances in the welding of large high-temperature gas-turbine rotors. It is understood that individual G18B disk and drum forgings have been successfully arc welded, using G18B electrode wire of normal composition, coated with a neutral refractory of their own manufacture. The individual portions of the rotor were arc welded together, taking every precaution, and the joints were subsequently machined, polished, and etched, and proved to be free from cracks or defects. The assembled rotor was then cold spun at overspeed, and the welds were re-examined to prove that the radial strains developed during the test in no way induced cracks in the weld metal. Following these successful tests, the rotor was then bladed.

Gas-turbine rotors constructed in this way have already run for considerable periods under working conditions, with complete satisfaction. The excellent welding properties of G18B steel have thus been independently verified.

HALLOCK C. CAMPBELL

**Properties of  
 Electroplates\***

AS A BROAD CLASSIFICATION, electro-deposition is used to achieve one or several of the following effects, either singly or in combination: decorative surfaces, protection of base metal from corrosion, increased hardness and reclamation of parts machined undersize, improvement of bearing properties, modification of electrical and thermal properties, improvement of luster and reflective properties, electrodeposition of alloys, fabrication of intricate shapes by electroforming, and other miscellaneous uses.

The typical plating specifications given are, in general, substantially lower in salt spray resistance re-

(Continued on p. 186)

\*Abstract of "The Physical and Engineering Properties of Electrodeposited Metals", by J. S. Anderson, a paper presented before the Australian Institute of Metals, Physical Metallurgy Division, at the Symposium on Electrodeposited Metals, 1949.

**JACO 70-15**

Stigmatic Grating

**SPECTROGRAPH and  
 VARISOURCE  
 EXCITATION UNIT**

SPECTROGRAPH (left, above): The only stigmatic grating instrument commercially available! Fully automatic instrument for fast, precise analysis of ferrous alloys, minerals and for use in dozens of other spectrochemical analytical problems. Electrical controls are simplified, and grouped for maximum flexibility and convenience. Toggle switch wavelength region shifting. Electromagnetic shutter controlled from source . . . 6" grating blank (15,000 lines per inch) for high optical speed and superior resolution . . . plateholder accommodates two 4" x 10" plates for maximum single exposure spectral coverage.

New VARISOURCE EXCITATION UNIT (right, above): All-in-one excitation source — includes DC arc, high-voltage AC arc and high-voltage tandem air-gap spark with oscilloscope control. High reproducibility and precision.

Write today for Bulletin  
 describing these  
 instruments —  
 address Dept. M

# *if it has to do with X-RAY inspection*

**whether it's x-ray equipment for FLUOROSCOPIC inspection**



Everything in equipment for fluoroscopic light metals and low density materials. Manual loading types, or travelling conveyor systems.

**or apparatus and accessories for TAKING radiographs**



Everything from a self-contained 50 KV unit up to a 24,000,000 volt betatron which can handle foot-thick steel. Films, cassettes, screens ... everything you need.

**or darkroom essentials, supplies for PROCESSING radiographs**



Everything from a small tank up to automatic processing systems which can turn out 120 finished 14" x 17" films per hour.

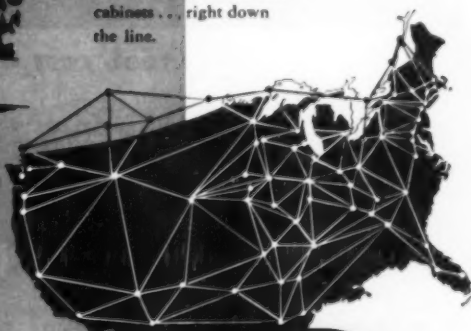
**or illuminators, scales, cabinets for VIEWING radiographs**



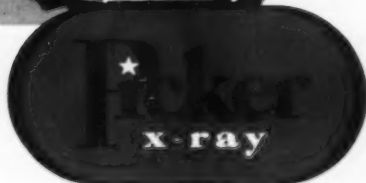
Banked illuminators, high-intensity viewers, filing envelopes, cabinets ... right down the line.

**wherever there's a dot on this map ...**

there's a Picker office ready to serve you. You'll find it in your local phone directory—or write us—Picker X-Ray Corporation, 300 Fourth Avenue, New York 10, N. Y.

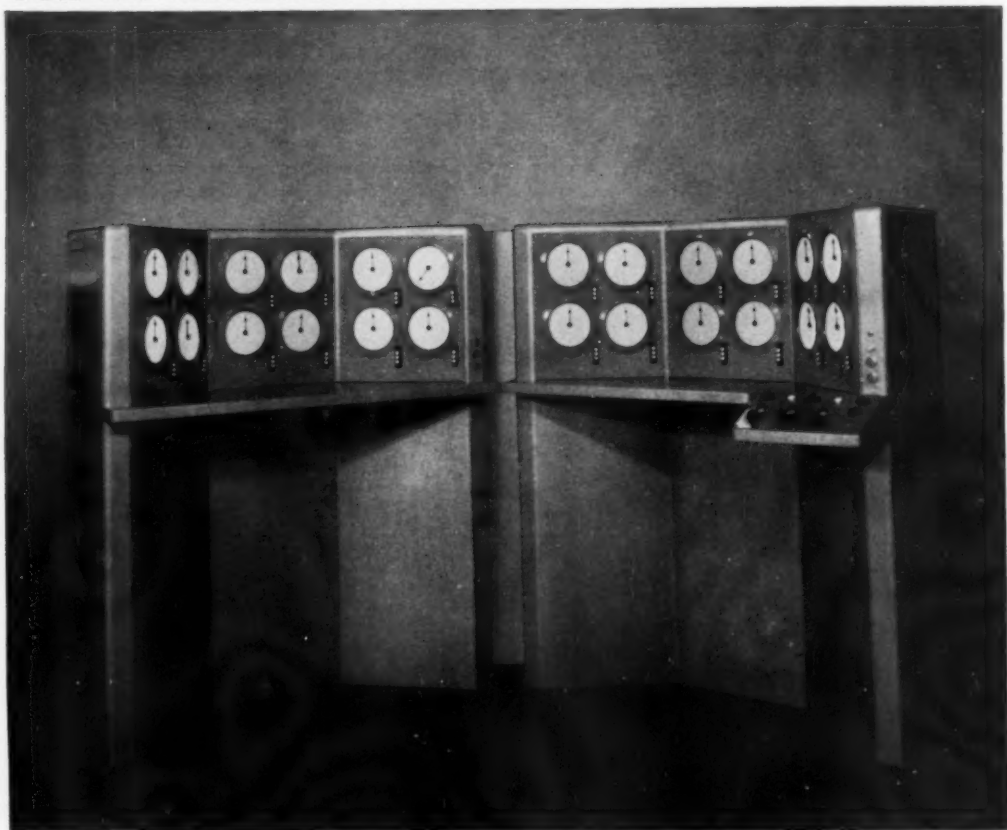


# *then it has to do with*



# TRULY A DIRECT READER

## FOR THE ANALYSIS OF COMPLEX ALLOYS—IN SECONDS!



### **steel, cast iron, aluminum, brass, magnesium**

Push button operation, clock dials are read directly in % concentration to provide accurate, reliable analysis in a matter of seconds. DIRECT READING ANALYSIS means increased furnace production, no heat lost due to "off analysis." Technical Bulletin #34 on the subject is furnished free and promptly to executive and technical personnel who request it on their letterhead.

Baird Associates will exhibit a model spectrographic laboratory and emission accessories in Booth H 427 during the Nat'l Metals Exposition in Detroit, October 15-18. We would be pleased to share any of your problems on instrumental analysis. Visitors to the show who are interested in seeing a Direct Reader in operation will please see P. C. Hutchinson in Baird Associates booth. Visit will be arranged through the courtesy of McLouth Steel Corporation.



*Baird Associates, Inc.*

33 UNIVERSITY ROAD

CAMBRIDGE 38, MASS.

# HD-N

## *Cuts Cleaning Time*

Cowles HD-N Cleaner, the *new* heavy-duty soak cleaner for ferrous metals, will often do in 10 minutes what it takes other cleaners 30 minutes or more to do. It is specifically formulated as a straight or barrel soak for precleaning before plating, enameling, pickling, painting, back-shop reconditioning—or anywhere a heavy-duty cleaner is needed to remove stubborn types of soil.

The latest developments in metal cleaning research have been incorporated in HD-N to assure maximum detergency under all conditions of usage.

HD-N may also be used on such active metals as brass and zinc, if some attack is acceptable.

HD-N penetrates and removes such soils as oil, carbon, grease, drawing compound, graphite, road and shop dirt in *one* cleaning operation. It is fast, thorough, and does a complete job . . . is readily and completely soluble in hot water.

### **COWLES CHEMICAL COMPANY**

Metal Cleaner Department

7016 Euclid Avenue • Cleveland 3, Ohio

*This booklet  
will be sent  
by filling in  
coupon.*

HEAVY DUTY  
CLEANING  
FAST WAY

Cowles Chemical Company  
7016 Euclid Avenue  
Cleveland 3, Ohio

Please send me booklet, "HEAVY DUTY  
CLEANING THE FAST WAY."

Name \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

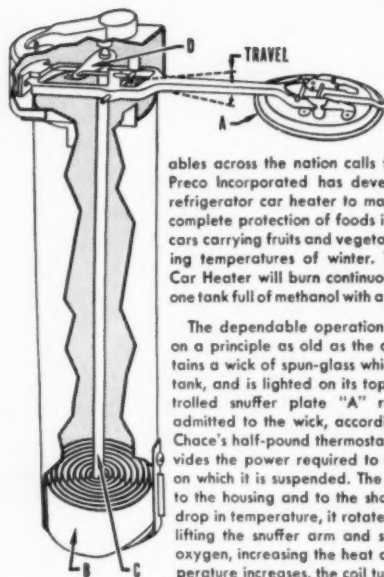
City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_





**CHACE'S  
Powerful  
Half-Pound**

**Preserves  
Precious  
Provisions**



The transportation of perishables across the nation calls for ingenuity to prevent spoilage. Preco Incorporated has developed this safe methanol-burning refrigerator car heater to maintain the proper temperature for complete protection of foods in the endless trains of refrigerator cars carrying fruits and vegetables across the country in the freezing temperatures of winter. The Preco Automatic Refrigerator Car Heater will burn continuously at full flame for fifty hours on one tank full of methanol with a heat output of 6000 BTU's per hour.

The dependable operation of this automatic heater is based on a principle as old as the candle snuffer. A central tube contains a wick of spun-glass which draws up the methanol from the tank, and is lighted on its top surface. The thermostatically controlled snuffer plate "A" regulates the amount of oxygen admitted to the wick, according to the temperature in the car. Chace's half-pound thermostatic bimetal coiled element "B" provides the power required to lift the snuffer plate and the arm on which it is suspended. The "heat motor" element "B" is fixed to the housing and to the shaft "C". As the bimetal reacts to a drop in temperature, it rotates the shaft with lever "D" attached, lifting the snuffer arm and snuffer plate, exposing the wick to oxygen, increasing the heat as required. If the surrounding temperature increases, the coil turns in the opposite direction, lowering the snuffer plate, leaving only a pilot flame.

This largest of all Chace thermostatic bimetal elements is fabricated to Preco specifications from Chace #6650, one of the 29 types available in strips, random length coils or complete elements. Our 64-page reference on the selection and design of thermostatic bimetal elements for temperature responsive devices may guide you in the development of your own products. Before your new design progresses to the tooling stage, however, be sure to consult the Chace Applications Engineers for the advice of qualified experts.



**W. M. CHACE CO.**  
*Thermostatic Bimetal*  
1626 BEARD AVE., DETROIT 9, MICH.

## Properties of Electroplates

(Continued from p. 182)

quirements than American specifications. For example, zinc or cadmium, 0.0005 in. thick on steel, is required to withstand only 48 hr. salt spray compared with 240 hr. for 0.0005 in. cadmium in American Specification QQ-P-416.

A table of Brinell hardness for electroplates is given as:

Chromium	400-950
Platinum	606-642
Rhodium	594-641
Palladium	190-455
Nickel	125-550
Iron	140-350
Copper	40-130
Silver	60-79
Cadmium	12-22
Zinc	40-50
Tin	8-9

When a composite plate of copper, nickel, and chromium fails as a result of high tensile stress, it is evident that most of the stress exists in the nickel plate. Since the tendency of highly tensile stressed nickel is to accelerate the rate of plate failure, an effort should be made to hold the stress to a minimum value. This can be accomplished by keeping the pH at the lowest operating value, maintaining the maximum temperature, careful control of addition agents, and taking precautions to plate from a clean and pure bath. The decorative chromium should be held to the minimum thickness.

The static properties of some steels are not adversely affected by embrittlement but the fatigue life is greatly impaired, and all parts subject to stress should be treated to remove hydrogen embrittlement before they are put into service. Acid pickling is responsible for embrittlement in most instances, and the effect increases with temperature up to approximately 120° F.

Hydrogen embrittlement may be removed and parts restored to nearly normal conditions by heating to a low temperature for some time, providing cracks have not developed after plating. If work is permitted to stand at room temperature for several days, hydrogen embrittlement is removed if the degree of embrittlement is slight. Several hours immersion in boiling water is sometimes used on low-carbon steel. However, for higher carbon steels used in high-tensile bolts and springs which are highly stressed, heating at 300 to 400° F. for 2 to 3 hr. is the practice recommended.

The electrical resistivity of plated  
(Continued on p. 188)

# NOW—COMPLETELY UNIFORM INDUCTION HEATING WITH BALANCED ELECTRICAL LOADING

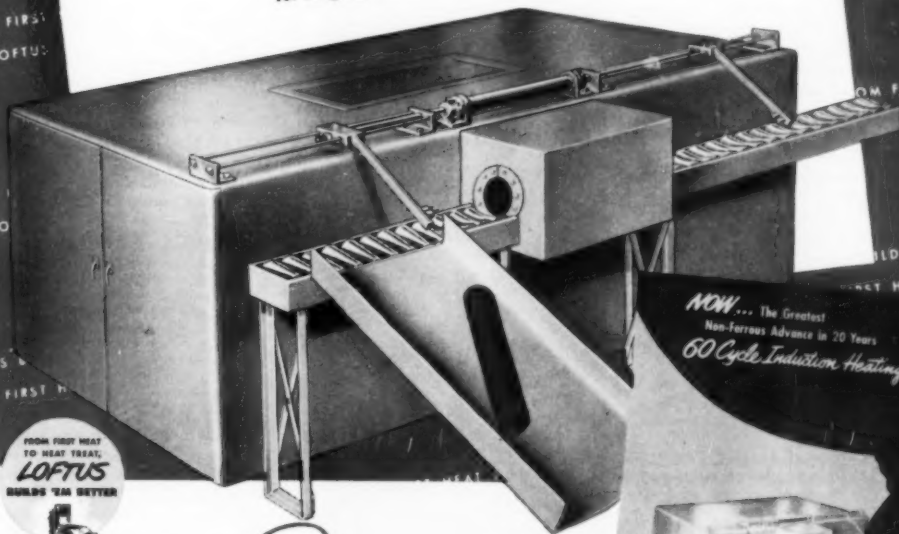
There is absolutely NO Comparison!

You can now profit from efficient induction heating that assures electrical balance on your power line. PLUS the amazing new "INTERTWIN" Coil that guarantees *uniform, efficient* heating of the billet.

The new Loftus Induction Furnace can't be equalled for clean, economical, efficient operation. Write for descriptive booklet today.

for Heating Aluminum, Brass, Copper,  
Magnesium and some applications  
of Steel  
for Forging — Extrusion — Rolling

by Loftus



## LOFTUS ENGINEERING

610 SMITHFIELD ST.

Corporation

PITTSBURGH, PA.

Designers and Builders of Industrial Furnaces



## The over-all job in

# Production Lines and Special Automatic Machines by CONTINENTAL

for military production...

For maximum production of military items manual operations must be eliminated. With CONTINENTAL Special Automatic Machines and Integrated Production Lines production goes on in a continuous flow with better, more uniform products with a minimum of man hours.

CONTINENTAL jobs begin with analysis of the requirements, then the selection and development of proper methods for greatest results. Finally follows the design, the building, and the installation of the machines—delivering a COMPLETE UNITIZED PRODUCING PACKAGE with results guaranteed.

The broad experience of CONTINENTAL offers you a prompt, sure solution to your change-over program.

**CONTINENTAL INDUSTRIAL ENGINEERS, INC.**  
176 W. Adams Street, Chicago 3, Illinois

District Representatives:  
Ridgewood, N. J. • St. Louis • Cincinnati • Detroit  
Milwaukee • Indianapolis • Cleveland • Pittsburgh



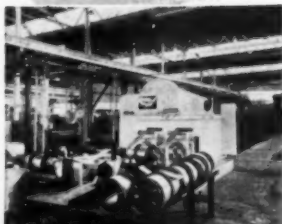
**PLANNED MILITARY  
PRODUCTION. Write for  
Booklet No. 127.**

FURNACES  
PRODUCTION LINES

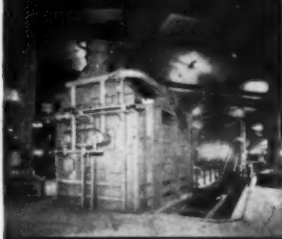
**CONTINENTAL**

SPECIAL MACHINES  
COMPLETE PLANTS

MANUFACTURERS-ENGINEERS-CONTRACTORS FOR OVER A QUARTER OF A CENTURY



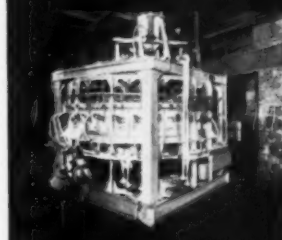
Continental Automatic Strip Production Line consisting of annealer, pickling machine, dryer, and cooler.



Continental Special Automatic Pig Melting Machine complete with automatic charging, melting, and pouring.



Continental Automatic Production Line operating from raw materials to completely finished and packed product. This production line consists of fifteen integrated, synchronized, special automatic machines.



Continental Special Automatic Glazing Machine complete with automatic press, synchronizer, and fire polisher.

## Properties of Electroplates

(Continued from p. 186)

coatings is tabulated and, as expected, silver, copper and gold head the list with resistivity values (microhm-centimeters) of 1.63 at 18° C., 1.72 at 20° C., and 2.44 at 20° C., respectively. Then follow chromium with 2.6 at 0° C., rhodium 5.11 at 0° C., zinc 5.75 at 0° C., cadmium 7.54 at 18° C., nickel 7.8 at 20° C., indium 8.37 at 0° C., cobalt 9.7 at 20° C., iron 9.8 at 20° C., platinum 9.83 at 0° C., palladium 11.0 at 20° C., tin 11.5 at 20° C., and lead with 22.0 at 20° C. This important property of electroplated metals is used extensively for electrical contact points, silver in particular being used because of its resistance to oxidation. An innovation of recent years is the plating of electrical circuits on plastic or other nonmetallic bases, a process similar to "printed circuits" now in use for the manufacture of compact, portable radio and other electrical equipment. This process involves the masking of all areas other than the electrical circuit, which is cut through the masking medium, and subsequent electrodeposition with silver or copper provides the current-carrying conductors of the circuit.

A table of thermal conductance values of 15 metals is given from the paper, "Physical Properties of Electrodeposited Chromium", by Brenner, Burklead and Jennings, *Journal of Research*, National Bureau of Standards, Vol. 40, 1948, p. 31-59.

The coefficients of friction of various metal combinations listed are:

METALS	STATIC FRICTION	SLIDING FRICTION
Steel on chromium-plated steel	0.14	0.12
Babbitt on chromium-plated steel	0.15	0.13
Steel on chromium-plated steel	0.17	0.16
Steel on babbitt	0.25	0.20
Babbitt on babbitt	0.54	0.19
Steel on steel	0.30	0.20

Perhaps the most significant use of chromium for improved bearing and wear resistance has resulted from the development of porous chromium. This is produced by subjecting hard chromium deposits to a short anodic treatment after cathodic deposition to widen the fine microscopic cracks in the surface. The microscopic cracks and fissures aid in retention of lubricating oils at bearing surfaces, and a marked increase in the life of cylinder bores, liners and piston rings of internal

(Continued on p. 190)

# HEAT TREATING FURNACES

## **For ALUMINUM**

**Aging • Pre-heating  
Solution heat treating**

## **For FERROUS METALS**

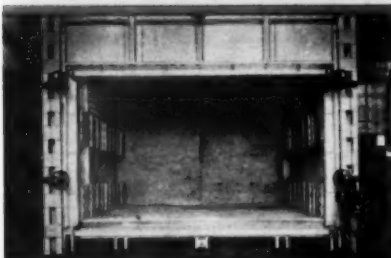
**Stress relieving • Normalizing  
Aging • Tempering • Drawing**

For all heating requirements up to 1350° F. where accurate heat control and uniformity in the work chamber is desired. Car bottom furnaces. Bottom entry quick quench furnace for solution heat treatment of aluminum. Conveyorized furnaces and all other material handling designs.



Laboratory furnace for research and production control.

## **DESPATCH**



Despatch Stress Relief Furnace, gas fired car bottom type. Has automatic pre-heating, soaking and cooling control.

Battery of Despatch pot type furnaces heat treating steel parts.



Despatch continuous conveyor furnace for steel heat treating.

## **DESPATCH OVEN COMPANY**

Write to Dept. P for more information.

Minneapolis Office:  
619 S. E. 8th St.

Chicago Office:  
4554 Broadway

# "HERE IS 4,500 cubic feet of gases"

FOR METAL TREATING!"

**Barrett**

Standard  
Anhydrous  
Ammonia



When dissociated, one 100-pound cylinder of Barrett Standard Anhydrous Ammonia (Refrigeration Grade) yields 4,500 cubic feet of mixed gases—approximately 3,400 cubic feet of pure hydrogen and 1,100 cubic feet of pure nitrogen.

You effect real economies when you use Barrett Standard Anhydrous Ammonia as a replacement for other more expensive sources of hydrogen and nitrogen.

Engineers have obtained many advantages from the use of dissociated ammonia as controlled atmosphere in furnaces for bright annealing, clean hardening, copper brazing, sintering, reduction of metallic oxides, atomic hydrogen welding, radio tube sealing and other metal treating practices. Anhydrous ammonia also has unsurpassed qualities in the nitriding of steel, used as ammonia gas or dissociated.

The advice and help of Barrett technical men are available to Barrett customers without charge.



## Barrett<sup>®</sup> Standard Anhydrous Ammonia

In 150, 100 and 50-pound cylinders for fast delivery from a stock point located near you. And in tank car shipments from Hopewell, Va., and South Point, Ohio.

**THE BARRETT DIVISION**  
ALLIED CHEMICAL & DYE CORPORATION  
40 RECTOR STREET, NEW YORK 6, N. Y.

America's Leading Distributor of AMMONIA

\*Reg. U. S. Pat. Off.



## Properties of Electroplates

(Begins on p. 182)

combustion engines has resulted from the use of this electrodeposit.

During the recent years, it has become possible to apply metallic coatings to nonconductors by electrodeposition. This has opened a wide field of possibilities, particularly in the electrical, radio and electronics industries. It has also been used for decorative effects.

Electroforming, the production of intricate shapes by electrodeposition, is described in general terms and some instances given, such as Pitot static tubes. The importance of this application of plating (sometimes called "cold casting") is properly emphasized.

ADOLPH BIEGMAN

## Fatigue Resistance of Heat Treated Aluminum and Beryllium Bronzes\*

ALUMINUM BRONZE (90.62 Cu, 9.27 Al, 0.07 Fe and 0.09% Zn) and beryllium bronze (97.26 Cu, 2.25 Be, 0.30 Ni and 0.10% Fe) were subject to fatigue and fatigue-corrosion tests in these heat treated conditions:

### Aluminum Bronze

1. Heated 1 hr. at 1620° F., quenched in water.
2. Treated as in 1 then reheated 1 hr. at 1110° F., air-cooled.

### Beryllium Bronze

1. Heated 40 min. at 1490 to 1510° F., quenched in cold water.
2. Treated as in 1 then reheated 1 hr. at 680° F., quenched in cold water.

The fatigue and corrosion-fatigue tests were carried out in rotating-beam machines. A fine mist of 3% salt solution was sprayed on the corrosion-fatigue specimens during the test.

The results of fatigue tests in air indicate that the fatigue limit, particularly in the aluminum bronze, is not reached at an endurance of 50 million cycles, and the values have therefore been recorded as endurance limits on that basis. The endurance limits for the present aluminum bronze in the heat treated conditions (about 25,700 psi. in the quenched

(Continued on p. 192)

\*Abstract of "The Resistance of Aluminum and Beryllium Bronzes to Fatigue and Corrosion Fatigue", by D. G. Sopwith, Reports and Memoranda No. 2486, Aeronautical Research Council.



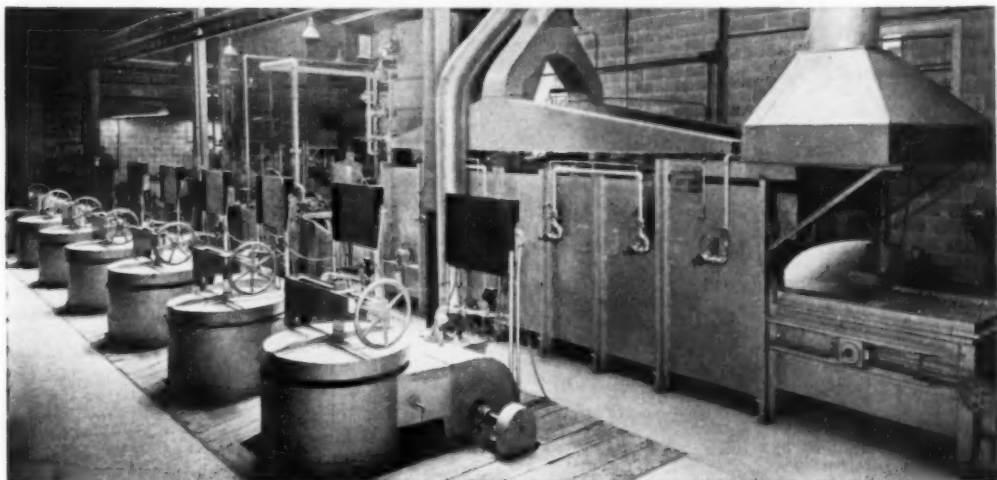
No. 109  
of a  
Series  
of Typical  
Installations

# Sunbeam STEWART

THE BEST INDUSTRIAL FURNACES MADE

HOW  
SUNBEAM STEWART  
FURNACES MEET  
THE DEMANDS  
ON THE  
PRODUCTION FRONT

## DEFENSE REQUIREMENTS CAN BE MET QUICKLY WITH PROVEN SUNBEAM STEWART HEAT TREATING EQUIPMENT



**HEAT TREATING ARMOR PIERCING SHOT.** During World War II, the conveyor type Sunbeam Stewart Hardening furnace, with a battery of pit-type recirculating Draw furnaces, shown above, handled the entire shot heat treating operation with a minimum of labor for one of the country's largest producers of 57 mm armor piercing shot. A thoroughly controlled quench with regulated quenching oil temperature obtains the optimum physical characteristics of the work in the hardening operation.

Armor piercing shot represents a difficult heat treating problem. The forward body is solid construction and must be hardened for maximum strength, the cavity section must be strong and more ductile. This hardness differential is necessary to provide maximum penetration while preserving the explosive qualities of a sealed powder chamber designed to explode immediately after penetration of the armor plate.

Hardness and toughness are important in the manufacture of A. P. shot. The correct physical properties must be accomplished in the heat treatment of the steel. Sunbeam Stewart heat treating installations provide the maximum hardness required at the point and throughout the shot thus meeting ordnance requirements with clean, solid armor piercing quality. This is a result of even, thorough heating of the uniformly spaced and positioned shot, with continuous flush quenching at shot tip using controlled temperature quenching oil.

**IF YOU ARE CONSIDERING DEFENSE WORK CALL SUNBEAM STEWART.** Designs are available for heat treating the following material:

**SHELLS:** 57MM; 75MM; 90MM; 105MM; 120MM; 155MM;  
3", 5", 6", 8" Navy Shells (Harden, Quench and Draw).

**FORGINGS:** Rotary Hearth and Pusher-type Forging Furnaces.

**ARMOR PIERCING SHOT** (Harden, Quench and Draw).

**CARTRIDGE CASES** (Anneal, Stress Relieve).

**MACHINE GUN CLIPS** (Harden, Quench and Draw).

**JET AIRCRAFT and TANK PARTS**

**SUNBEAM STEWART INDUSTRIAL FURNACE DIVISION of Sunbeam CORPORATION**  
(Formerly CHICAGO FLEXIBLE SHAFT CO.)

Main Office: Dept. 108, 4433 W. Ogden Ave., Chicago 23 — New York Office: 322 W. 48th St., New York 19 — Detroit Office: 3049 E. Grand Blvd., Detroit  
Canada Factory: 321 Weston Rd., So., Toronto 9

A letter, wire or 'phone call will promptly bring you information and details on SUNBEAM STEWART furnaces, either units for which plans are now ready or units specially designed to meet your needs. Or, if you prefer, a SUNBEAM STEWART engineer will be glad to call and discuss your heat treating problems with you.



## 12-14% CHROME TYPE ALLOY

**Norman S. Mott**

*Chief Chemist and Metallurgist*

This composition is a mildly corrosion-resistant alloy capable of being heat treated for a variety of properties including high strength and hardness. It has a low coefficient of expansion, is tough, machinable, weldable, and finds extensive use in valve bodies, valve trim, pump parts, grinding units, etc., especially in power plants, oil refineries, and paper mills. The alloy has suitable corrosion resistance for applications involving superheated steam, hot oil, food-stuffs, and some neutral salts; however, it will rust to a slight extent in a moist atmosphere. Its low cost, high strength, high hardness and wear resistance, coupled with an appreciable amount of corrosion resistance, make it an ideal alloy for specific applications where these factors are of primary importance.

This alloy is supplied in three carbon ranges: under 0.15% C, 0.15 to 0.25% C, and 0.25 to 0.35% C, these being designated as CA 14S, CA 14L and CA 14H respectively. The carbon range selected depends upon the final degree of hardness desired as well as other properties. Increasing carbon up to 0.25% increases hardness appreciably in the quenched, and quenched and drawn below 900° F. condition. Above 0.25% the increase in hardness is slight and these higher carbon contents, unless the slightly greater hardness is very essential as in wear applications, are not generally recommended, as ductility and shock resistance are seriously lowered.

In the quench hardened condition this alloy has its best corrosion resistance. Drawing the quench hardened material at 600° F. increases the ductility and shock resistance without decreasing the hardness to any appreciable extent, and without any effect on the corrosion resistance. It also is very effective in eliminating hardening stresses and the danger of cracking, and so is highly recommended.

The best hardness range for machinability is 220-240 BHN. This

range is best obtained by tempering at 1200° F. for under 0.15% C, at 1300° F. for 0.15 to 0.25% C, and at 1400° F. for 0.25 to 0.35% C. Softening to too low a hardness causes gumming and poor machinability; also it causes low maximum hardness upon rehardening.

Molybdenum in amounts of 0.4 to 0.6% is sometimes added to improve machinability and high temperature creep resistance. Copper is often added to the extent of 1.0% to improve corrosion resistance and is occasionally combined with molybdenum additions. Nickel in amounts of over 0.75% and silicon over 1.0% are to be avoided. Nickel greatly increases the hardness in the tempering ranges used for machinability and necessitates lengthy special heat treatments. Silicon has a very detrimental effect on impact resistance when the alloy is drawn at 600° F.

Heat treatment for all carbon ranges of this alloy consists of oil quenching or air cooling from 1800° F. after slowly heating to temperature and holding for one hour, followed by tempering for 3 to 4 hours at the correct temperature necessary to obtain the desired properties. Tempering temperatures of from 900-1100° F. are to be avoided as this range produces low corrosion resistance and mechanical properties. Oil quenching from the hardening temperature produces slightly higher hardness values than air cooling, but is not practical for large castings. A hardening temperature of 1900° F. will produce slightly higher hardness values upon quenching in the 0.25 to 0.35% C grade.

### Available on request

Copies of this article in convenient filing form, and a table of mechanical properties for conditions of heat treatment most commonly used, are available.



**COOPER  
ALLOY**  
Stainless Steel  
VALVES - FITTINGS - CASTINGS

able. Address requests to Publicity Dept., The Cooper Alloy Foundry Co., Hillside, N. J.

## Fatigue Resistance of Heat Treated Aluminum and Beryllium Bronzes

(Continued from p. 190)

and 22,400 psi. in the quenched and reheated condition) are considerably lower than of the previous (8.9% Al) aluminum bronze tested in the as-received condition (extruded and drawn, 31,900 psi.), although there is little difference in the ultimate stresses.

The fatigue test results in air on the beryllium bronze are interesting. Normally, the effect of heat treatment on a material tested in the polished condition is to increase its fatigue strength almost in proportion to its ultimate tensile stress, the endurance ratio (ratio of fatigue limit to ultimate stress) decreasing slightly as the ultimate stress increases. In the beryllium bronze, however, there is little variation in fatigue strength (36,400 to 43,700 psi.) for a wide variation in ultimate stress from 71,700 to 181,500 psi. There is thus a very marked decrease in endurance ratio as the ultimate stress increases. A notch-sensitive material would be expected to behave in this way when a high degree of stress concentration is present, due to a sharp change of form. The reason in the present case may be similar, due to internal stress or to flaws set up during the heat treatment. No indication was observed of the presence of such flaws. The value of 0.54 for the endurance ratio of this material in the soft state is exceptionally high for a nonferrous metal.

The logarithmically plotted stress-endurance curves for the corrosion-fatigue tests are, in the case of the aluminum bronze in both conditions and the beryllium bronze in the quenched condition, straight lines, with some very slight initial curvature at endurance values below about 2 million for the quenched and reheated aluminum bronze. This agrees with all previous corrosion-fatigue tests conducted at the National Physical Laboratory. The results on the quenched and reheated beryllium bronze show some scatter, but are probably adequately represented by a curve which shows a fairly pronounced curvature up to about 10 million cycles. In neither of the two materials did heat treatment (either quenching alone, or quenching and reheating) give a corrosion-fatigue endurance limit as high as that of the material in the as-received (extruded and drawn) condition.

(Continued on p. 194)



a compact,  
complete small mill. No cellars or elaborate foundations needed

**T**O meet the need of many manufacturers for a small, compact, inexpensive mill for the cold rolling of narrow, thin strip, UNITED developed, and is now offering, a NEW, COMPLETELY INTEGRATED "PACKAGE MILL."

Each unit is furnished fully equipped with roller bearing mounted rolls, recirculating rolling coolant system, mill guides, tension reels, belt wrappers if desired, strippers, motors and drives, all mounted on a fabricated base which serves also as a rolling coolant reservoir. The mill illustrated is a reversing type with motorized screwdown.

If a small, compact, completely self-contained "Package Mill" of this type fits into your present operations or contemplated expansion, consult us. Your inquiry will bring complete information at no obligation.

- Mill can be equipped for one way rolling by using a simple coil box instead of a reel.
- Sleeve type or collapsing mandrels are optional with or without grippers to meet user's requirements.
- Hand screwdown can be furnished instead of motorized screwdown as shown.

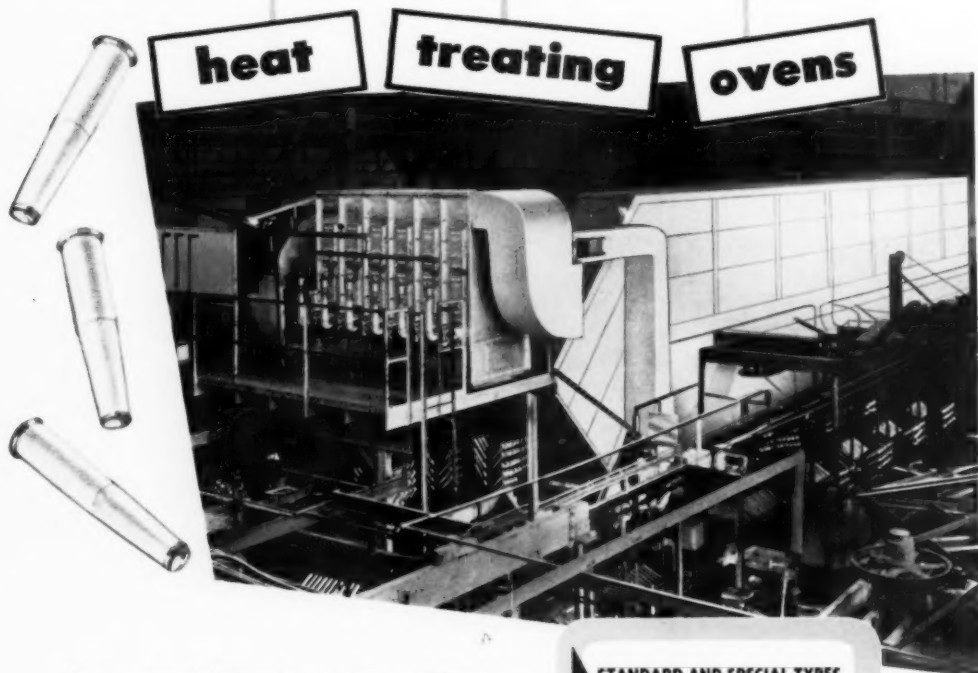
## UNITED ENGINEERING AND FOUNDRY COMPANY Pittsburgh, Pennsylvania

Plants at PITTSBURGH • VANDERGRIFF • NEW CASTLE • YOUNGSTOWN • CANTON

Subsidiaries: ADAMSON UNITED COMPANY, AKRON, OHIO • LOBDELL UNITED COMPANY, WILMINGTON, DELAWARE  
STEEDMAN FOUNDRY AND MACHINE CO., INC., AURORA, INDIANA

Designers and Builders of Ferrous and Non-Ferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.

*...speed up defense production with*  
**YOUNG BROTHERS**



Heat treating shells is only one of many defense jobs that Young Brothers Ovens are handling with top efficiency. Today, Young Brothers Ovens, batch and conveyors types with accurately controlled temperatures up to 1000°, are speeding up production in hundreds of defense plants.

Through the services of Young Brothers engineers, you get the advantage of 55 years of experience in building ovens for your specific needs. These services—available without obligation—can help you speed up your production and cut costs. Write or call for more details.

**STANDARD AND SPECIAL TYPES  
TO MEET PRODUCTION  
REQUIREMENTS AND PLANT  
CONDITIONS FOR  
SUCH PROCESSES AS:**

- ANNEALING AND TEMPERING
- DRYING AND IMPREGNATING
- AGING PROCESSES
- NORMALIZING AND STRESS RELIEF
- HYDROGEN RELIEF AFTER PLATING
- PREHEATING PROCESSES
- TEMPER DRAWING



◀ **WRITE FOR BULLETIN 14T.**

**YOUNG BROTHERS COMPANY**

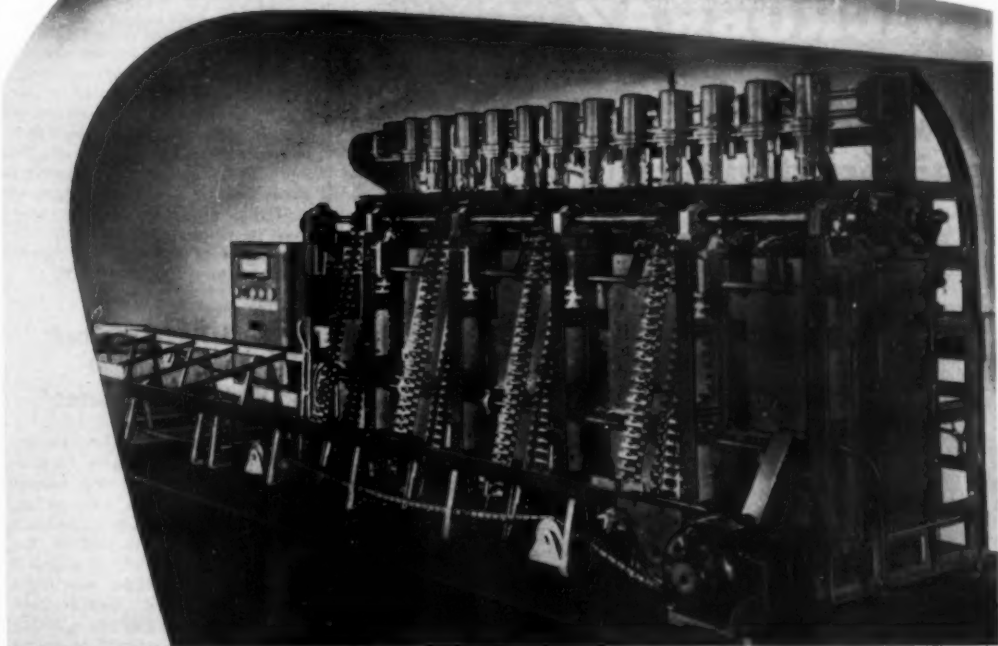
1829 COLUMBUS ROAD

CLEVELAND 13, OHIO



Established 1896

# Continuous Bar Heating Furnace



*See this*  
**OPERATING  
MODEL**

**Booth C-229**  
National Metal Show  
Detroit, Michigan  
October 15-18, 1951

## INHERENT ADVANTAGES

A vertical slot-type furnace with positive feed and discharge.

Completely automatic conveying mechanism.

Precision heating of each bar.

Saving of 25% to 50% in fuel and floor space.

Flight conveyors handle bars  $\frac{3}{8}$ " diam. to  $2\frac{1}{2}$ " diam.  
and 3 ft. to 50 ft. long.

Production up to 300 bars per hour.

# DREVER

## COMPANY

790 East Venango Street  
Philadelphia 34, Pa.





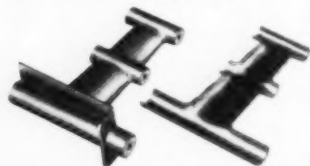
A jet turbine stator section fabricated of cobalt base alloy and AISI 316 stainless steel, brazed with Nicrobraz.

## NICROBRAZ

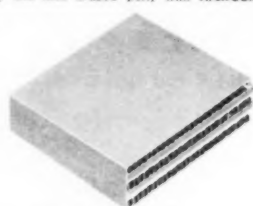
### New corrosion resistant alloy brazes stainless steel for 2000° F. service

COLMONOY Nicrobraz is a heat and corrosion resistant nickel-chrome alloy, developed primarily for brazing stainless steels and special alloys. It has these highly desirable qualities:

**Nicrobraz resists high heat.** A Nicrobraz joint in a stainless steel assembly has a tensile strength equal to that of the parent metal while the assembly is operating at 2000° F. This quality ranks Nicrobraz above any other known material for brazing parts for service in the high temperatures of modern aeronautical power plants.



Previously cast, this fuel injection nozzle support assembly is now stamped (right) of S 590 stainless alloy and then brazed (left) with Nicrobraz.



Heat exchanger is made up of five corrugated and six flat sheets of 316 stainless steel, .010" thick. Brazed with Nicrobraz in one operation.



Mercury bulb and tube assembly. Tube is .032" stainless steel with .006" I.D. hole. Five joints brazed in one operation with Nicrobraz.

**Nicrobraz resists oxidation and corrosion.** It is extremely resistant to the action of most chemicals and retains its physical properties under oxidizing conditions. Previously, for lack of a corrosion resistant brazing alloy, many stainless steel assemblies have been machined from the solid, or welded or assembled by mechanical means. With Nicrobraz they'll be made more easily and at less cost. Nicrobraz will change design thinking in many industries, such as: aeronautical, automotive, food, dairy, pharmaceutical, nuclear energy, control instruments, chemical, and oil refining.

Nicrobraz is available as a powder or in strip and shim stock. It flows readily at 2100° F. in a pure dry hydrogen atmosphere, and will penetrate a contact joint by capillary action. When brazing stainless steels, a stable new alloy is formed by the Nicrobraz alloying with the parent metal. Its ductility, strength, and corrosion resistance is then about the same as that of the parent metal and it has a much higher melting point than the original Nicrobraz.

Wall Colmonoy Corporation maintains a plant at Detroit with the equipment necessary for the development and production of stainless steel joining operations utilizing Nicrobraz. Bright annealing, bright hardening, complete heat treating, and the brazing of stainless steel and other alloys can also be processed in our plant.

For more information contact Wall Colmonoy Corporation, 19345 John R Street, Detroit 3, Michigan.

Branches: Long Island City, Buffalo, Chicago, Houston, Los Angeles, Montreal.

**WALL COLMONOY**  
CORPORATION

HARD FACING ALLOYS

19345 JOHN R STREET DETROIT 3, MICHIGAN

### Fatigue Resistance of Heat Treated Aluminum and Beryllium Bronzes

(Continued from p. 192)

The endurance ratio of aluminum bronze does not vary much with heat treatment over the small range of ultimate stress covered; that of the beryllium bronze, however, as in tests in air, varies widely. In the two heat treated conditions, the endurance limit in salt spray is about 80% of that in air, the extruded and drawn condition giving a value 7% higher than that in air. The small effect of heat treatment on the corrosion-fatigue resistance is to be expected as the latter is affected more by composition and internal stress than by the ultimate stress or air fatigue limit. In this case, moreover, as pointed out above, the fatigue limit in air also was almost independent of heat treatment.

### Centrifugal Method of Testing at High Temperatures\*

**P**RESENT methods of testing high-temperature strength, such as creep and rupture tests, require complex apparatus, long testing times, and are limited to a maximum temperature of 1470 to 1560° F. Because of the complexity of classical creep testing methods, substitutes have been proposed. One of these involves the sagging of wires, either under their own weight or under an external load. Bochner, in 1947, proposed testing the change in hardness and showed that this placed aluminum alloys in the same order of merit as did creep testing. However, this method is limited to tests at 1380 to 1490° F. Odling suggested a split-ring specimen that permits testing simultaneously 20 specimens and magnifies the deformation 2000 times. Kornilov, in 1941, used wire or strip specimens mounted as cantilever beams so that they bent under their own weight at elevated temperatures. This bending occurred at 1830° F. (for alloy steels); however, at lower temperatures it was

(Continued on p. 198)

\*Abstracted from "Centrifugal Method of Testing the Strength of Metals and Alloys at High Temperatures", by I. I. Kornilov, *Zavodskaya Laboratoriya*, 1949, p. 76-82; and "The Centrifugal Method of Testing Metals and Alloys at High Temperatures", by M. E. Rabinovich, *Zavodskaya Laboratoriya*, 1949, p. 988-993.

## DOES IT TAKE 8000 HOURS TO TRAIN A TOOL & DIE MAKER?

If so he's an important person—too important to be spending his time and talent on steel of uncertain work value, or on routine "get-ready".

Designed especially for him are WARPLIS squares and flats of truly fine quality oil hardening, *non-warping*, tool steel in this standard analysis which he knows and trusts:

Carbon .90 Manganese 1.10 Chromium .50 Tungsten .50 Vanadium .15


... each piece ready for his advanced skills—precision ground and decarb-free, corners square, sides flat and parallel.

His nearest fine steel distributor carries WARPLIS in the wide range of sizes shown below—each piece marked with size and brand, each in its own protective wrapper bearing simple heat treatment:

### Squares

Stock Sizes,  
18" Lengths

$\frac{1}{8}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3
---------------	----------------	----------------	----------------	---------------	----------------	---------------	---------------	---------------	---------------	---	----------------	----------------	---	----------------	---

Thickness (Inches) 	Width (Inches)														
	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	5	6	8	10	
$\frac{1}{64}$															
$\frac{1}{32}$															
$\frac{3}{64}$															
$\frac{1}{16}$															
$\frac{3}{32}$															
$\frac{1}{8}$															
$\frac{5}{32}$															
$\frac{3}{16}$															
$\frac{1}{4}$															
$\frac{5}{16}$															
$\frac{3}{8}$															
$\frac{1}{2}$															
$\frac{5}{8}$															
$\frac{3}{4}$															
1															
$1\frac{1}{4}$															
$1\frac{1}{2}$															

Larger, smaller and in-between sizes, and special lengths, to order.

Also Warplis Drill Rod  
ROUNDS  
Nearly 200 Stock Sizes

PRICE FOLDERS ON REQUEST

# Warplis

FLAT STOCK

PITTSBURGH TOOL STEEL WIRE CO.  
MONACA, PA.

Since 1902 . . . makers of cold finished fine  
steels in all sizes, grades and shapes

# A COMPLETE LINE OF INDUCTION HEATING EQUIPMENT TO MEET EVERY PRODUCTION NEED

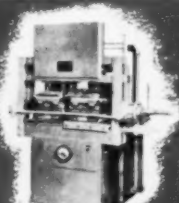
# ECCO

**SPARK GAP CONVERTERS  
TUBE DRIVEN OSCILLATORS  
HIGH FREQUENCY MOTOR GENERATORS  
LOW FREQUENCY 60-CYCLE INDUCTION HEATERS**

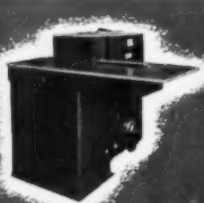
CALL ON ECCO!—for controlled heating applications by induction or conduction



\* ECCO Model M40 60-Cycle Induction-type Ring Gear Expansion Heater with automatic heat control and pneumatic release. Units available ranging from 20 to 100 KW.



\* ECCO Model M47 Valve Stem Heating and Forging Machine. Completely automatic with push button control. Heats and die forms stems from round bar stock. Handles all sizes.



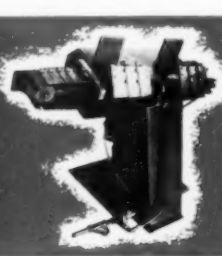
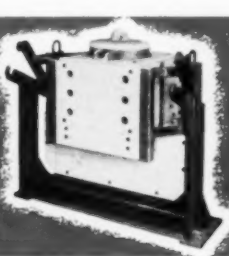
\* ECCO Spark Converter and Conveyor-type Induction Soldering Machine. Units available ranging in capacities from 1 1/4" to 35 KVA.



\* ECCO High Frequency Centrifugal Casting Machine with retractable induction heater coil and variable speed motor drive for precision castings.



\* ECCO Model F78 550-pound Tilting-type High Frequency Induction Melting Furnace. ECCO can supply high frequency induction melting furnaces ranging from a few ozs. to several tons.



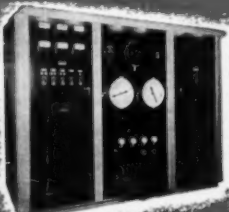
\* ECCO Model M14 Conveyor-type Induction Hardening, Quenching and Drawing Machine. Capacity 2500 parts per hour.



\* ECCO Model 06-50 KW Water-cooled, Tube-driven Oscillator. Output frequency range, 500 KC to 30 MC.



\* ECCO High Frequency 2-Position Brazing Stand with pneumatic positioning fixture, automatic timing and temperature controls.



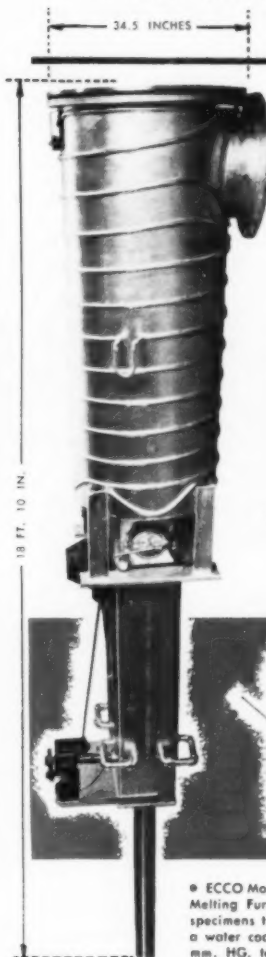
\* ECCO High Frequency Motor Generator and Controls. Installations available from 20 to 1200 KW at operating frequencies from 960 to 10,000 cycles with melting capacity from 5 pounds to several tons.



\* ECCO 35-KVA Spark Converter with high frequency power distribution for 4 induction melting furnaces.

**ECCO HIGH FREQUENCY CORP.**  
7020 HUDSON BOULEVARD  
NORTH BERGEN, N. J.  
DESIGNERS AND

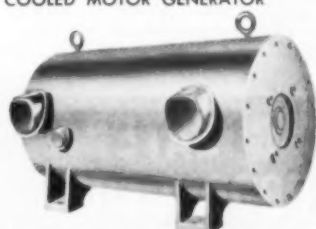
# ECCO HIGH FREQUENCY VACUUM MELTING EQUIPMENT



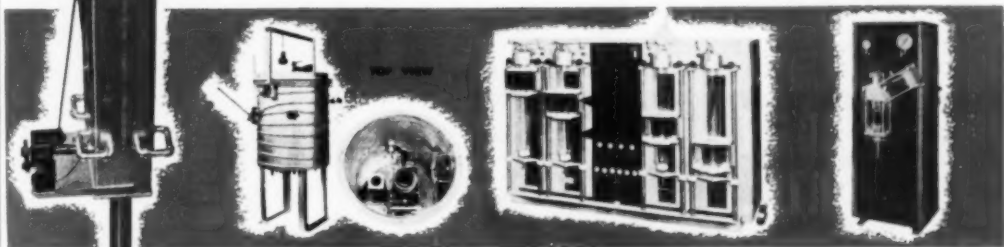
## ONE OF THE LARGEST VACUUM FURNACES EVER BUILT

● ECCO Model VFR 11 Vacuum Heat Treating Furnace measures 18 ft. 10 in. in height with top diameter of 34.5 inches. Model VFR 11 includes mechanism to lower the charge into a cooling zone while still in vacuum. Operating pressure is  $10^{-5}$  mm. HG.

● 100 KW TOTALLY ENCLOSED WATER COOLED MOTOR GENERATOR



**ACCESSORIES FOR ALL INDUCTION HEATING AND MELTING OPERATIONS**—ECCO can supply motor generator sets, induction heating coils, inductor blocks, quench heads, capacitors and other specialties for every induction heating and melting application. ECCO engineers will make recommendations on specific needs.



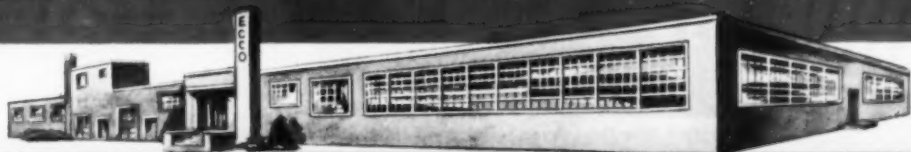
● ECCO Model F66B Coil Tilting Type High Vacuum Melting Furnace with provisions to add alloying specimens to the charge and pour the metal into a water cooled mold. Operating pressure  $10^{-4}$  mm. HG. temperature  $2000^{\circ}$  C+. Unit capacity available from 30 to several hundred pounds.

● ECCO Model F64 Four-Position High Vacuum Degassing Furnace, complete with sliding induction heater coils, pumps and vacuum gauges.

● ECCO Model F65, 2 to 10 pound Vacuum Melt, Pour and Pressure Furnace. Furnace has provision for preheating the mold.

## IF YOU HAVE A PROBLEM

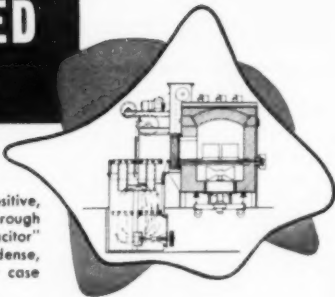
concerning industrial electric heating, ECCO engineers will place their years of specialized experience at your disposal to help work out a practical, economical solution. Standard ECCO equipment in many different models is available for production and research. Where special custom designing is required, ECCO will design or build to the exact specifications of your own engineers. Either way, your inquiry will receive prompt, competent attention. Call or write ECCO today!



**MANUFACTURERS OF INDUSTRIAL HIGH FREQUENCY HEATING EQUIPMENT**

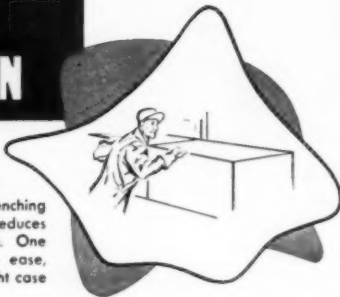
## UNSURPASSED QUALITY

Combines the operating economies of large continuous furnaces with the flexibility of batch-type equipment. Positive, directed flow of furnace atmosphere through load, combined with the "heat capacitor" assures rapid, uniform heating on dense, bulk-loaded parts and even on light case work.



## GREATER PRODUCTION

The Dow Furnace has established production records in plants throughout the country. Forced, uniform quenching from atmosphere gives full hardness, reduces distortion, eliminates decarburization. One man can operate two furnaces with ease, producing as much as 1500-lbs. of light case work per hour.



## WIDER VERSATILITY

Whether it's gas cyaniding, gas carburizing, clean hardening or carbon restoration work, the Dow Furnace is capable of processing a variety of parts having a wide range of heat treatments. To demonstrate the close tolerances of heat treatments, send us samples of your own parts for processing.



## AT LOWER COSTS

Reductions in direct labor, material handling, machining and cleaning costs, coupled with improved quality, have resulted in savings amortizing the original cost of the Dow Furnace in a few months. Gas cyanides for 1/4 to 1/2 the cost of liquid cyaniding.



FIRST  
WITH MECHANIZED BATCH-TYPE  
CONTROLLED ATMOSPHERE FURNACES

12045 Woodbine Ave. • Detroit 28, Michigan  
KEnwood 2-9100

• AT THE NATIONAL METAL SHOW BOOTH A-349 •

## Testing at High Temperatures

(Continued from p. 194)

necessary to use several hundred gram loads at the ends of the specimens, and it was difficult to design suitable apparatus.

The centrifugal method of testing alloys is based on the deformation of the specimens at high temperatures under the continuous action of centrifugal force. This force can be applied to cause bending or tensile elongation, and it can be used to study creep. The method of investigating deformation in bending is most practical since no complicated equipment is required and a large number of small specimens can be tested simultaneously. Tension testing is also relatively easy by the centrifugal method, and in certain temperature ranges the creep behavior of a large number of specimens can be studied simultaneously. Machines for both types of testing were built.

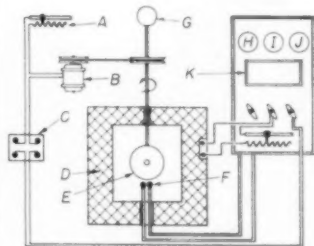


Fig. 1—Centrifugal Equipment for Testing High-Temperature Strength

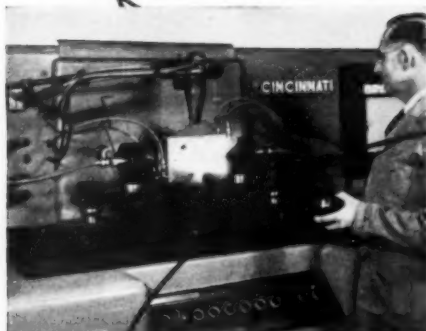
The machine for testing specimens in bending is shown schematically in Fig. 1. Specimens were held at one end in a fixture attached to the lower end of the rotating shaft. Initially, the axes of the rod specimens were vertical, but the centrifugal force tended to cause them to bend outward toward the furnace walls.

Resistance to bending was measured in degrees of the angle of bend or in millimeters of displacement. The speed of rotation was varied by means of a rheostat; constant speed was insured by a voltage stabilizer. Cylindrical specimens 3, 4, 5 and more millimeters in diameter were tested in groups of 12, 24 or more. The specimens weighed 5 to 10 g. and were easily prepared in the cast or wrought condition.

By taking periodic deformation readings it was possible to con-

(Continued on p. 202)





1950 Metal Show, Chicago: transmission hubs



1949 Metal Show, Cleveland: wrench jaws



1948 Metal Show, Philadelphia: drive shafts



1947 Metal Show, Chicago: ring gears



**for the fifth consecutive year**

Five years ago Flamatic selective surface hardening was demonstrated for the first time—in production—at the Metal Show in Chicago and made front-page news as an important new tool for industry. At each succeeding Metal Show, Flamatic was shown in production on difficult heat treat jobs.

Once again we invite you to—

## **see flamatic in action**

selectively hardening the lobes of an internal cam for a newsmaking automotive transmission. (Flamatic handles 2000 of these parts a day at the customers plant, with practically no rejects.) As in previous demonstrations, you'll be able to learn how Flamatic may help improve your product and lower your costs. Our staff of application engineers will be on duty to give personal attention to your problems.

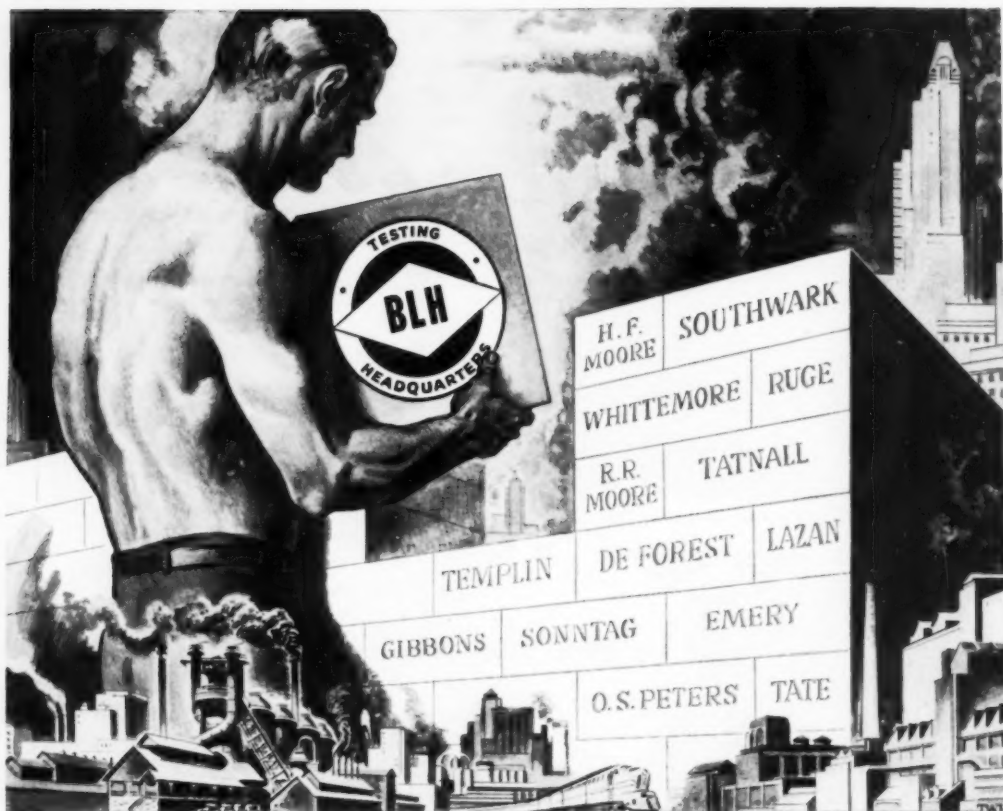
**visit booth G-356  
metal show: detroit  
october 15-19**

# **flamatic**

**THE CINCINNATI MILLING MACHINE CO.**

Cincinnati 9, Ohio, U.S.A. •

**CINCINNATI**



## TESTING HEADQUARTERS is built on a Foundation of FAMOUS NAMES

You know these names—for every one represents a major contribution to the science and art of materials testing. And every one has helped to make B-L-H Testing Headquarters the source of the newest in all varieties of fine testing equipment.

Over the years, Testing Headquarters has been a Clearing House for pioneering ideas, where every new development was sure of a welcome and a hearing. The results appear in such typical items as the line of fatigue testers, the versatile strain gage devices, the trail-blazing high-temperature testing equipment. Many of the most spectacular develop-

ments of the past decade rest squarely on the new, significant data provided by these new fact-finding machines.

Perhaps improvements in your present lines, or the development of new products are waiting on more accurate knowledge of the service properties of materials or components. If so, you will find it profitable to discuss the problem with one of our representatives.

If we don't have equipment ready to do the job for you, the composite experience behind these famous names is available to develop a right answer.

### MORE FAMOUS NAMES AT TESTING HEADQUARTERS

YORGIADIS • NADAI  
MANJOINE • BEAN • BLANKS  
VON HEYDEKAMPF  
NORTON • MONTGOMERY  
OSTERBERG • HASKELL  
BEGGS • TROXELL • LUERSSEN  
GREENE • BOHN • FLADER  
NASON • TRIPOLITIS  
SMITH • BIERMAN • LUBAHN

VISIT US AT BOOTH 311—BUILDING D  
NATIONAL METAL SHOW



# BALDWIN-LIMA-HAMILTON

TESTING HEADQUARTERS

Eddystone Division • Baldwin-Lima-Hamilton Corporation • Philadelphia 42, Pa.

In Canada: Peacock Bros., Ltd., Montreal, Quebec

# DO YOU HAVE A **HOT** DESIGN PROBLEM?

*then consider.....* **HIGH STRENGTH**  
at  
**HIGH TEMPERATURE...**

## KENTANIUM

You can really put the heat on this material! It's new. It's distinctive—in properties and performance. It withstands high temperature punishment that quickly weakens and disintegrates conventional heat-resistant materials. It goes through a "fiery furnace" and comes out practically "unscaled" . . . resists oxidation up to 2200°F over long periods, and up to 4500°F for short exposures. Shows no weakening

when subjected to the thermal shock of alternate heating and cooling from 1800°F to 180°F in one minute cycles for 100 hours continuously while under tensile stress of 12,500 p.s.i. Superior to best currently-used alloys in stress rupture characteristics from 1500°F up. Much lighter than steels or conventional alloys—a property especially valuable for rotating parts.

### KENTANIUM CONTAINS NO TUNGSTEN OR COBALT

Kentanium—our own exclusive development—is chiefly titanium carbide (small percentages of other refractory metal carbides) with nickel "binder." *Uses neither tungsten nor cobalt.* Can be had in various sintered forms—extruded rods, tubes, squares, and flats—simple molded shapes—or more intricate

forms that are machined from pressed powder slugs. Not heat-treatable . . . can be worked after sintering only by grinding, to produce required dimensional tolerance or surface finish. Several "grades" are available, with properties to meet specific combinations of imposed conditions.

*✱ If you're sweating over a hot design problem that has you stopped cold, perhaps Kentanium can come to your rescue with possibilities for providing longer life and greater efficiency. We invite your inquiries. Our engineers will be glad to work with you in determining the applicability of Kentanium to your design projects.*



**KENNAMETAL Inc.**

LATROBE, PA., U. S. A.

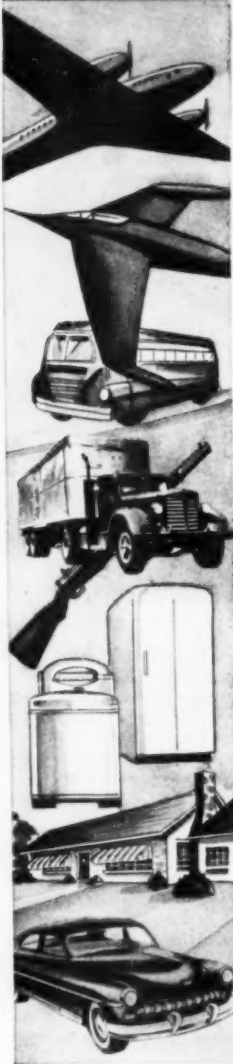
SUPERIOR CEMENTED CARBIDES

See our demonstrations of KENTANIUM at the A.S.M. Show, Detroit • SPACE G-252



phosphate  
coating  
chemicals

TO  
MAKE  
YOUR PRODUCT  
**DURABLE**



### **PAINT BONDING**

"GRANODINE"® forms a zinc-iron phosphate-coating bond on sheet metal products—automobile bodies and fenders, refrigerator cabinets, etc.—for a durable, lustrous paint finish.

"LITHOFORM"® makes paint stick to galvanized iron and other zinc and cadmium surfaces.

"ALODINE"®, the new ACP protective coating chemical for aluminum, anchors the paint finish and protects the metal.

### **RUST PROOFING**

"PERMADINE"®, a zinc phosphate coating chemical, forms on steel an oil-adsorptive coating which bonds rust-inhibiting oils such as "Granoleum."

"THERMOIL-GRANODINE"® a manganese-iron phosphate coating chemical, forms on steel a dense crystalline coating which, when oiled or painted, inhibits corrosion.

### **PROTECTION FOR FRICTION SURFACES**

The oiled "THERMOIL-GRANODINE" coating on pistons, piston rings, cranks, camshafts and other rubbing parts, allows safe break-in operation, eliminates metal-to-metal contact, maintains lubrication and reduces the danger of scuffing, scoring, galling, welding and tearing.

### **IMPROVED DRAWING AND COLD FORMING**

"GRANODRAW"® forms on pickled surfaces a tightly-bound adherent, zinc-iron phosphate coating which facilitates the cold mechanical deformation of steel, improves drawing, and lengthens die life.

Send for descriptive folders and Government specifications chart on the above chemicals. Write or call for more information on these products, and advice on your own metal-working problem.

Pioneering Research and Development Since 1914

**AMERICAN CHEMICAL PAINT COMPANY**

**AMBLER, PA.**

Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

## **Testing at High Temperatures**

(Continued from p. 198)

struct curves of deformation versus time for various materials. These curves showed a slightly increasing rate of deformation with increasing time until the constant, maximum deformation was nearly reached. Because the stronger specimens showed no bending during the first several hours, a possible measure of high-temperature strength would be the time necessary to cause bending to begin.

There is a definite advantage in using initial bending as a strength criterion since the bending force increases as bending proceeds and reaches a maximum at 40 to 45°. Possible quantitative measures of the strength of various alloys are: (a) Time necessary for initial plastic deformation at a given stress, (b) initial velocity of deformation, (c) time necessary for a given amount of deformation, (d) time necessary for maximum deformation.

Tests were run on ferrous high-temperature alloys using specimens 0.158 in. in diameter and 3.94 in. long, a temperature of 1830° F., and a speed of 1500 r.p.m. A ferritic chromium-aluminum alloy (EI 340) bent almost 90° in 15 min., two austenitic alloys (EI 69 and EI 310) bent about 60° in 2.5 hr., Timken alloy bent about 40° in 10 hr., and Vitallium bent only 3° in 160 hr.

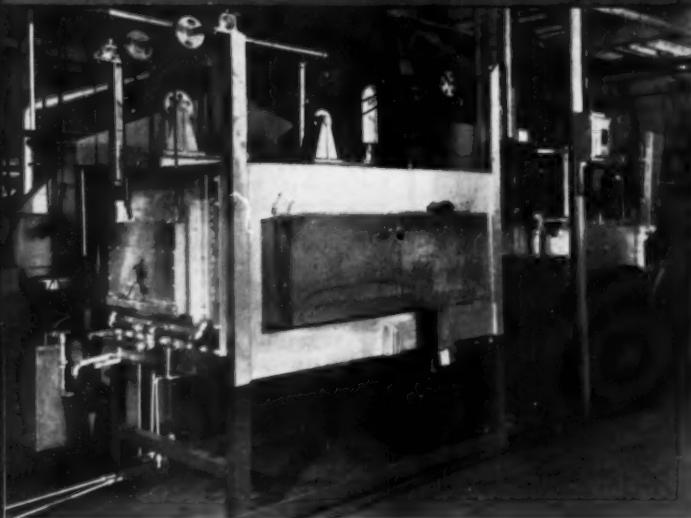
Tests were run at 570° F. on a series of aluminum-magnesium alloys containing from 0 to 12% magnesium after these alloys had been slowly cooled from a four-hour treatment at 750° F. The strength increased with increasing magnesium content up to the limit of solid solubility and then rapidly decreased to the lowest values at 10 and 12% magnesium.

Alloys containing up to 50% chromium of the 3:1 iron-nickel section of the iron-nickel-chromium diagram were studied at 1420° F. Again the alloy containing the maximum amount of chromium (about 25%) without the appearance of a second phase showed the highest strength.

There are two methods of reducing the time needed to determine the high-temperature strength of alloys. First, the time needed for each test can be reduced. Second, the number of specimens that can be tested at one time can be increased. An example of the first

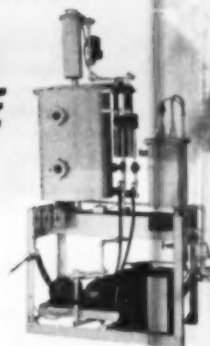
(Continued on p. 204)

"Hardening very long dies without any distortion," says Victor Mfg. and Gasket Co.



about their  
**HAYES FURNACES**

with  
*Precision Control*  
of  
**FURNACE  
ATMOSPHERE**



One of the largest manufacturers of automobile cylinder head gaskets, Victor Manufacturing and Gasket Company expresses all around satisfaction with Hayes "Certain Curtain" controlled atmosphere furnaces. Their dies are heat treated consistently with perfect surface, long-life working hardness and freedom from distortion. There is a great deal of know-how behind such results and Hayes offers to put it to work on your hardening problems. Depend upon Hayes know-how, the Hayes lab, and Hayes world-leader equipment, to give you the BEST in modern heat-treating results.

**CALL OUR NEAREST REPRESENTATIVE — REQUEST LATEST CATALOG**

**C. I. HAYES INC. 74 BAKER ST., PROVIDENCE, R. I.**

R. G. HESS  
Box 711, 24 Journal St.  
Jersey City, New Jersey

E. T. BURRIS AGENCY  
Box 884, 1920 Euclid Ave.  
Cleveland 15, Ohio

C. A. HOOKER  
222 Forest Ave.  
Royal Oak, Mich.

DOLAN INDUSTRIAL SALES  
Union National Bank Bldg.  
Houston, Texas

L. WAGNER  
112 Leucy Avenue  
San Jose 12, Calif.

L. J. EDWARDS  
New England Bldg.  
75 Baker St., Prov., R. I.

W. G. FRANK  
415 N. Dear St.  
Chicago, Ill.

JOHN E. FOWLER CO.  
1125 Le Clair Ave., Detroit 26  
Pittsburgh 15, Pa.

T. C. JARRETT  
2801 Wilkes St.  
Denver 11 Colorado

**ELECTRIC CERTAIN CURTAIN FURNACES**





# 8 OK's

on every Arcos  
Stainless Electrode



## Rigid Quality Controls GUARANTEE Better Weld Metal

• There's no room for guesswork in manufacturing Stainless Electrodes that will produce consistently high quality welds on every application. That's why the raw materials that go into Arcos Stainless Electrodes must meet rigid specifications . . . why every electrode must pass so many quality tests before it's put to use. It means complete assurance that the weld metal will be physically, chemically and metallurgically right for the job you want to do.

### ARCOS CORPORATION

1500 South 50th Street • Philadelphia 43, Penna.

## WELD WITH

# ARCOS

Specialists in Stainless, Low Hydrogen and Non-Ferrous Electrodes



## Testing at High Temperatures

(Begins on p. 194)

procedure is the use of the impression produced by an indenter as a qualitative measure of creep. This method requires only four hours, but it is limited to relatively low temperatures. Other short-time creep testing methods are known, but all of them become less reliable as the time of testing is decreased. Also, it is difficult to evaluate the effect of phase changes or recrystallization. Finally, high stresses must be used in these short-time tests, while much lower stresses are used in practice.

The centrifugal force method of Kornilov gives an opportunity of utilizing the second alternative, increasing the number of specimens tested at one time in a given machine. This method was one of those used in investigating the high-temperature strength of aluminum-copper-magnesium-zinc alloys. Specimens of the 16 compositions were prepared in rod form and were stabilized by a 200-hr. treatment at 570° F. following quenching and aging.

All of the tests were carried out at 570° F. The specimens were 0.158 in. in diameter and 3.94 in. long, and 12 specimens were run simultaneously. A fiber stress of 1400 psi. was produced by the speed of rotation which was 1500 r.p.m. The criterion of high-temperature strength was the time necessary for the amount of bending to reach 0.079 in. A plot of this quantity versus composition is shown in Fig. 2.

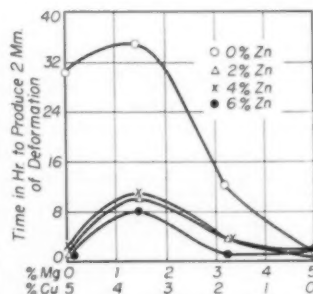


Fig. 2—High-Temperature Values for Aluminum-Base Alloys Obtained on the Kornilov Machine

Long-time hardness tests were made on the same specimens using a special apparatus. The loads were chosen so that the final diameters were within the limits 0.35 d. and

## Testing at High Temperatures

0.6 d., where d. is the 0.197-in. diameter of the steel balls used. The loads were applied for 50 min., and the hardness was determined by the Brinell formula. Effect of composition on the hardness of aluminum-copper-magnesium alloys is shown in Fig. 3.

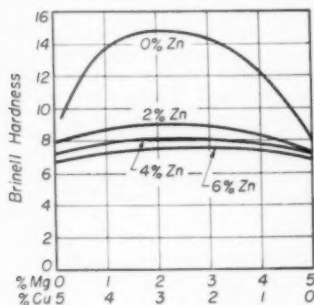


Fig. 3 — Hardness Values for Aluminum-Base Alloys Using a 50-Min. Testing Time

Ordinary creep tests were run on the specimens containing 1.6% Mg, 3.4% Cu, and from 0 to 6% Zn. The measure of creep strength used was the deformation produced in 100 hr. by a stress of 1400 psi. These results are shown in Fig. 4.

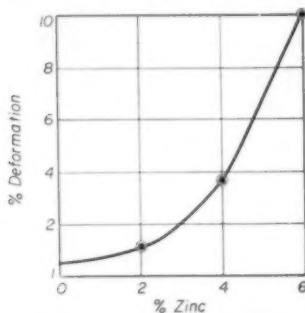


Fig. 4 — Deformation of Aluminum-Base Alloys (1.6% Mg, 3.4% Cu and Zinc) Produced by a 1400-Psi. Load Applied 100 Hr.

A comparison of the results of the centrifugal method and of the long-time hardness method shows that they give the same qualitative rating of the high-temperature strengths of a group of alloys. In this instance the aluminum-copper-magnesium alloys have the best high-temperature strengths, with a maximum lying on the line joining

(Continued on p. 206)

## Arcos Low Hydrogen Electrodes Replace Stainless For Welding High Tensile Steels

• Each day sees a growth in the requirements of nickel and chromium for defense production. The increased use of low hydrogen electrodes on welding high tensile steels is helping to free more of these critical alloys.

ARCOS low hydrogen electrodes are far removed from the experimental stage—they've already been "time tested and approved" on armor welding, as well as commercial applications. With them you get trouble-free, uniform welding performance because every one must pass the same rigid quality controls set up for Stainless.

### ARCOS CORPORATION

1500 South 50th Street • Philadelphia 43, Penna.

## WELD WITH

# ARCOS

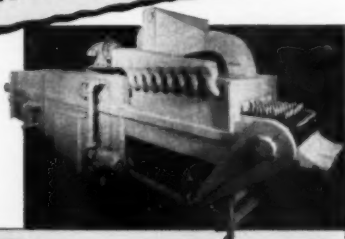
Specialists in Stainless, Low Hydrogen and Non-Ferrous Electrodes



Visit Our Booth No. H-502  
**NATIONAL METAL EXPOSITION, Detroit, Michigan**  
 October 15-19, 1951

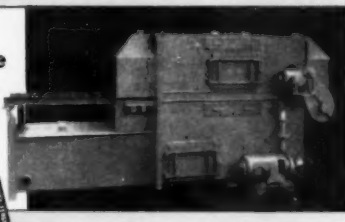
**EFFICIENT DEFENSE PRODUCTION**  
*Calls for*  
**EFFICIENT CLEANING METHODS!**

**For Cleaning  
 SHELLS**



**For Cleaning  
 CARTRIDGES**

**For Removing Cyanide  
 from HARDENED  
 GUN PARTS**



Write  
 for Your  
 Free  
 Copy—  
 Today

**YOUR METAL  
 REARMAMENT  
 PRODUCTS**  
 are  
**HANDLED  
 and CLEANED**  
*Mechanically*

**YOUR METAL CLEANING  
 PROBLEMS ARE ANSWERED  
 IN THIS NEW FREE BOOKLET**

Efficient methods of handling, as well as cleaning, metal products for defense—are fully described and pictured. Many questions now in your mind—are answered.



**THE ALVEY-FERGUSON CO.**  
 163 Disney St. Established 1901 Cincinnati 9, Ohio  
 Offices or Representatives in Principal Cities—Coast-to-Coast

**CONVEYING EQUIPMENT**  
**Alvey-Ferguson**  
**WASHING MACHINES FOR INDUSTRY**

METAL PROGRESS; PAGE 206

## Testing at High Temperatures

(Begins on p. 194)

aluminum and the "S" phase. The creep results are also in good agreement with those obtained by the centrifugal method.

A mathematical analysis of the bending force on the specimen in the centrifugal method showed that the bending force reaches a maximum value 2.835 times the initial force at an angle of bending of 40°. This increasing bending force explains why this method is more sensitive than the long-time hardness test.

It is proposed that additional work be done to determine the relation between velocity of deformation and the amount of deformation. Also, emphasis is made of the undesirability of interrupting the test to take deformation readings.

A. G. GUY

## Oxygen Cutting\*

A CHARACTERISTIC of oxygen cutting is the drag line. Drag, the distance measured parallel to the surface between the top and bottom of the cut, is explained as the resultant of three velocities: (a) the speed of advance of the torch, (b) the speed of oxidation, (c) the actual cutting speed. The relationship of these three factors of drag is shown in Fig. 1 and 2. The width and depth

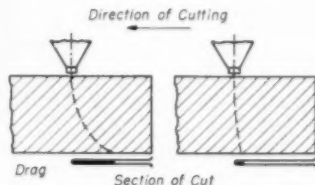


Fig. 1—Diagrams Showing Formation of Drag Lines. (Left) Large drag results when cutting speed is too high or oxygen supply too small. (Right) Normal drag is obtained using correct speed and oxygen supply

of drag lines depend a great deal on cutting conditions. In manual cutting, the irregularities inherent in hand guidance result in deep drag lines while machine cutting produces thin, regular drag lines. High-speed motion photography was se-

(Continued on p. 208)

\*Abstracted from a translation of "New Data on the Oxygen Cutting of Steel", by F. Pfeleiderer, *Journal de la Soudure*, Vol. 38, 1948, p. 151-160.

# NEED DEPENDABLE ALTERNATE MATERIAL including QUICK TOOL-UP and DELIVERY?

## OILITE CAN HELP YOU NOW



Oilite Finished Machine Parts — with NO Machining

**AMPLEX** MANUFACTURING COMPANY

*Subsidiary of Chrysler Corporation*  
DETROIT 26, MICHIGAN

OILITE PRODUCTS INCLUDE heavy-duty, oil-cushion, self-lubricating, ferrous-base bearings; Oilite bronze\* and other nonferrous\* bearings; self-lubricating cored\* and bar\* stock; permanent filters; and friction units.

\*Field Engineers and Representatives throughout U.S. and Canada.

### Here's how:

Oilite finished machine parts provide dependable replacements for bronze, brass, aluminum, cast iron, steel, and plastics. Frequently, replacements are permanent.

#### Oilite Material

Many Oilite raw materials, i.e., metal powders, are produced from by-products, readily available.

#### Tooling

Using Oilite finished machine parts, you save

- Tooling programs
- Tool Design
- Machine Tools
- Jigs and Fixtures
- Cutting Tools
- Gages
- Floor Space
- Skilled Manhours

Amplex type tools are, by comparison, inexpensive. Tool and die making facilities are available.

#### Delivery

Making Amplex tools generally requires only days or weeks and no additional machines.

#### Case Histories

Under conditions like today's we were in quantity production within six (6) weeks or less compared to eighteen (18) months by other processing.

#### Service

Our engineering and research covers a period of more than twenty (20) years in the production of Oilite metal powder products.

Home office personnel is augmented by a large staff of field engineers located in principal cities of the United States and Canada.

**OILITE**  
PRODUCTS

# Be Certain WITH "SERV-RITE"

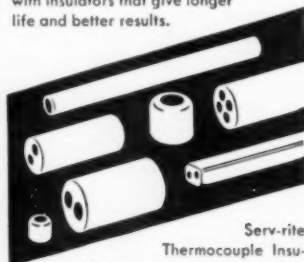
## THERMOCOUPLE INSULATORS



This Gordon Thermocouple Insulator, heated red hot and plunged into cold water, came out just as good as new

Available only through GORDON, Serv-rite Thermocouple Insulators are made to stand the gaff of excessive thermal shock far above normal requirements.

For sturdy and reliable thermocouple insulator performance to meet peak production needs—specify Serv-rite . . . a development backed by Gordon's many years' experience in supplying industry with insulators that give longer life and better results.



Serv-rite Thermocouple Insulators—in any type or size—can be supplied immediately from Gordon's large stocks in the Chicago and Cleveland plants. Remember—you can always distinguish Serv-rite Insulators by their tan color.

Fish Spine Beads      Asbestos String  
Asbestos Tubing      Single Hole  
Double Hole Round      Double Hole Oval

**GORDON  
SERVICE**

**CLAUD S. GORDON CO.**  
Manufacturers & Distributors

Thermocouple Supplies • Industrial Furnaces & Ovens  
Pyrometers & Controls • Metallurgical Testing Machines  
Dept. 15 • 3000 South Wallace St., Chicago 16, Ill.  
Dept. 15 • 2035 Hamilton Ave., Cleveland 14, Ohio

## Oxygen Cutting

(Continued from p. 206)

lected as the best means of obtaining information on the cutting action.

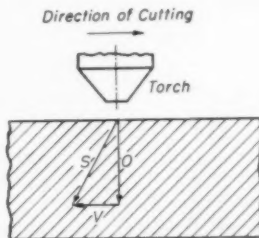


Fig. 2—Vector Diagram of Drag Lines. V = speed of advance of torch; O = velocity of oxidation; S = actual cutting speed

The purpose of the research was to secure a more exact understanding of the nature of oxygen cutting and to understand the origin of drag lines in the hope of improving the smoothness of oxygen-cut surfaces. The high-speed cinematography was done in the Zeiss plant with a camera capable of taking as many as 3000 frames per sec. The plate to be cut was mounted on the cross-head of a lathe so that the torch could be held stationary and in focus. The cuts were made along the edge of the plate for convenience in viewing. The pictures were taken on 35-mm. color film with very high intensity lighting supplementing the illumination provided by the cutting torch.

The film shows that the process of oxygen cutting is a completely continuous one; if oxygen supply and rate of advance of the torch were absolutely uniform, the cut would be perfectly smooth. Slag plays an important part in cutting, the progress of combustion through the thickness of the plate being aided by the heat of combustion itself and the heat in the molten slag. Without the heat from the slag, cutting would be impossible, because the hottest part of the preheating flame is only a few millimeters ahead of the tip of the inner cone and it cannot furnish enough heat to the deeper parts of the cut. This seems particularly true in the cutting of very thick sections where the required preheat is furnished principally by the slag.

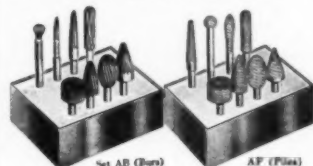
The origin of gouges in the surface of a cut made at too slow a speed is explained by the cutting jet finding more favorable points of attack on the sides of the cut when its speed of advance becomes too

(Continued on p. 210)

## MARTINDALE

### ROTARY BURS AND FILES

Made of high-speed steel. Produced in our own factory where uniform hardness is assured by heat-treating in electric furnaces on which the temperature is closely controlled by electric eyes.



Sets AB & AF

Per Set

1 set . . . . .	\$11.05 net
2 to 11 sets . . . . .	9.75 net
12 or more . . . . .	8.45 net

The above sets, with  $\frac{1}{8}$ " diameter shanks, are composed of the 8 most popular sizes for general use.

Over 200 sizes and shapes (total over 75,000 pieces) are carried in stock for immediate shipment.

### METAL-WORKING SAWS



Made of 18-4-1 High Speed Steel in 4 types for ferrous and nonferrous metals. Diameters range from  $1\frac{3}{4}$ " to 4".

### "MOTOR-FLEX" GRINDERS



These high-quality, portable flexible-shaft tools are made in 7 types for operation on bench, floor, or overhead.

Write for 64-page Catalog No. 28 covering above and many other products for maintenance, safety, and production.

**MARTINDALE ELECTRIC CO.**  
1372 Hird Avenue, Cleveland 7, Ohio



# SPRA-LUBE

*Lubricates the Overspray*

. . . each particle of paint is coated with a non-volatile solvent. And as it hits the water curtain, it can't stick to the back panel or any of the eliminators . . . The booth keeps clean and the sludge remains floating for easy skimming . . . The use of "SPRA-LUBE" guarantees lowest material and maintenance costs. Let our technicians consult you on this or any of your other cleaning problems — there are thirty-five specialized NORTHWEST products in this field alone.



**NORTHWEST CHEMICAL CO.**  
9310 ROSELAWN      DETROIT 4, MICH.

pioneers in pH cleaning control — serving you since '32

## Oxygen Cutting

(Begins on p. 206)

great. The jet progresses in this new direction until it finds new material on the forward surface of the jet, over which the slag can flow.

In the removal of the molten material (iron and iron oxide) from the cut, it was observed that part of the material was driven down the sides of the cut and blown out by the oxygen jet, the remainder being rejected in back of the cutting jet. The molten material becomes visible back of the cutting jet only a certain distance below the surface of the plate. The zone at the upper edge of a smooth cut where no drag lines are in evidence is the zone that shows no molten material back of the jet.

The high surface tension of the slag is believed to be the main reason for the formation of drag lines. The movies revealed a periodic breaking loose of molten material from the jet each time the supply of molten material from the front of the cut was exhausted.

The author's conclusions are:

1. The jet moves continuously in the direction of cutting, with no lateral deviations.

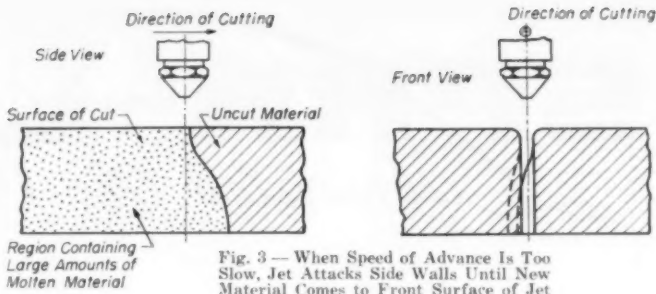


Fig. 3 — When Speed of Advance Is Too Slow, Jet Attacks Side Walls Until New Material Comes to Front Surface of Jet

2. The cutting jet has no gyratory motion.

Forward Motion of Cutting Jet

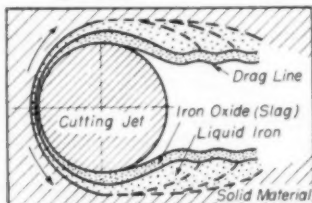


Fig. 4 — Molten Material Formed in the Cut Is Rejected to Rear Where It Forms Drops Which Rapidly Solidify

3. Good combustion is shown by the presence of slag which acts to preheat the metal.

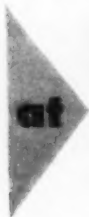
4. If the cutting speed is too slow, the jet attacks the side walls of the cut instead of the front wall until the torch has advanced sufficiently to bring new material to the front surface of the jet.

5. Most of the molten material formed in the cut is rejected to the rear where, by reason of its high surface tension, it forms drops which freeze rapidly. The small depressions formed between overlapping drops constitute the drag lines.

S. FEIGENBAUM

**BRING YOUR CARBIDE PROBLEMS TO**

**ADAMAS**  
Carbide Corporation  
HARRISON, NEW JERSEY



**BOOTH H-218**

**NATIONAL METAL EXPOSITION  
DETROIT • OCTOBER 15-19, 1951**

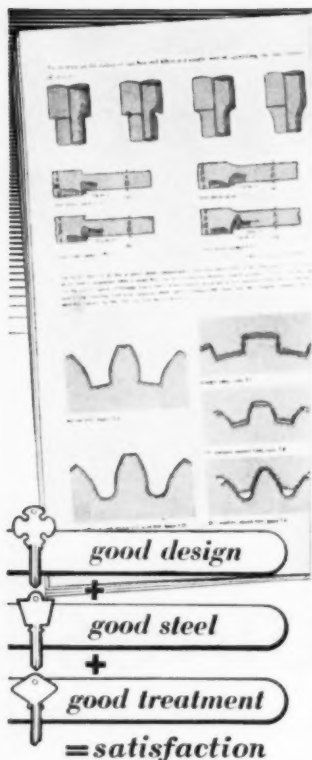


## QUALITY FORGINGS

**When questions arise on forgings** of carbon, alloy and stainless steels, high temperature alloys, and strategic metals — such as titanium — our metallurgical and engineering departments will gladly work with you.

**Write for** 4-page folder, "Stainless and High Temperature **FORGING ALLOYS** and Drop Forging Tolerance Data".

**THE STEEL IMPROVEMENT & FORGE CO.**  
**970 E. 64 St.                      Cleveland 3, Ohio**



If you are a design engineer seeking success with steel components, you will find help towards your goal on every page of this 72 page booklet. Write now for "3 Keys to Satisfaction"—it is valuable and it is free.

## Climax Molybdenum Company

500 Fifth Avenue  
New York City

Please send your  
FREE BOOKLET  
3 KEYS TO SATISFACTION



Name.....  
Position.....  
Company.....  
Address.....  
MP-10 F20

## Explosion Deformation Tests of Weldments\*

IN THE Naval Research Laboratory bulge tests of full butt welded joints, loading was applied by an explosive charge—using a standard military demolition explosive—in the shape of a wafer located 12 to 24 in. above the test plate. This explosive can be readily shaped to a circular or elliptical wafer of desired size.

The test weldment consisted of a 20 x 22-in. plate produced by butt welding two 10-in. wide plates. For testing, the weldment was placed over either a circular (6-in. radius) or elliptical (radii of 7.5 and 4.8 in.) opening cut in 4-in. thick armor plate. The die opening was chamfered to facilitate entry of the bulge into the die cavity. The explosive wafer, supported above the plate by a cardboard box, was electrically detonated. Unsupported area of the weldment was approximately 28% of the total area. It was found that the size of the bulge could be closely controlled by varying the weight of charge and amount of standoff.

Information was obtained regarding the nature of plastic deformation of welded joints with matching and overmatching weld metals. Both balanced and unbalanced stress fields were included. With the unbalanced stress fields, weld orientations were varied with reference to the direction of major stress. All strain measurements were made at arbitrary levels well below the critical strain-producing fracture.

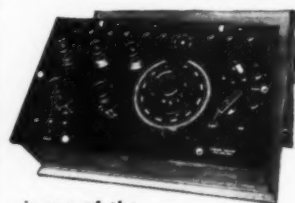
Material used was  $\frac{3}{4}$ -in. thick, silicon-killed firebox steel plate. Butt joints were of two types: a single-pass submerged arc weld of square geometry and a manual multipass double-V weld of geometry similar to that used in ship construction. The submerged arc weld metals were a low carbon, 2% manganese, and a composition similar to S.A.E. 6130. Manual welds were made with an E12016 electrode. Tests also were made on prime plate to provide a reference basis for comparison.

The low-alloy submerged arc weldments were tested under three conditions:

(Continued on p. 215)

\*Abstract of "Explosion Bulge Test Studies of the Deformation of Weldments", by C. E. Hartbower and W. S. Pellini, *Welding Research Supplement*, Vol. 16, June 1951, p. 3078-3178.

## Precise TEMPERATURE MEASUREMENT



### is one of the many applications of the TYPE B HIGH PRECISION POTENTIOMETER

... a general purpose potentiometer with a number of notable refinements, suiting it particularly to thermocouple work. Distinctive features include:

- Three ranges — 0 to 16 millivolts, 0 to 160 millivolts and 0 to 1.6 volts.
  - Three reading dials—effective scale length of approximately 175 feet for each range.
  - Subpanel switch and slidewire construction for protection of contacts from dust and corrosive fumes.
  - Special provisions to minimize parasitic thermal emf's—including automatic compensation of slidewire thermals and gold contacts in galvanometer key.
  - Exceptional convenience in reading and adjustment.
  - Solid and substantial construction for many years of trouble-free service.
- This standard laboratory potentiometer is also well suited for meter calibration, for checking portable potentiometers, and for other critical measurements of D.C. potentials requiring exceptionally high accuracy.

Described in Bulletin 270



### SPOTLIGHT GALVANOMETER FOR SHOP AND LABORATORY WORK

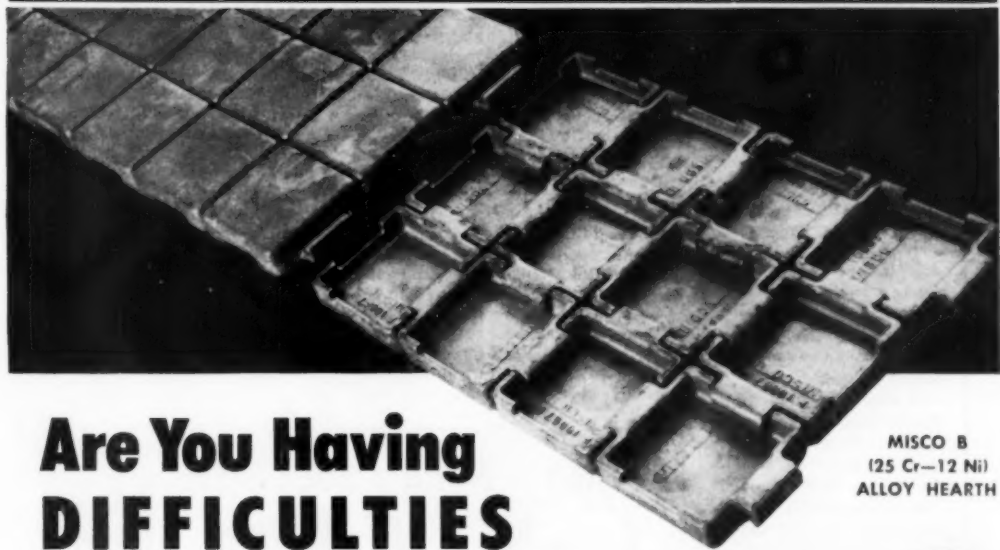
- Sturdy, short period
  - Sensitive (up to 1.5  $\mu$ V per mm.)
  - Multiple-reflection optical system
  - 100-Millimeter scale
  - For null or deflection measurements
- Described in Bulletin 320

## RUBICON COMPANY

Electrical Instrument Makers  
3758 Ridge Avenue • Philadelphia 32, Pa.

# MISCO *Flexible* FURNACE HEARTHS

Heat Resisting • Wear Resisting • Shock Resisting



MISCO B  
(25 Cr—12 Ni)  
ALLOY HEARTH

## Are You Having DIFFICULTIES with Your FURNACE HEARTHS?

WE CURED OUR TROUBLES with our Misco Flexible Furnace Hearth. Made in interlocking alloy sections the Misco Flexible Hearth will not distort. If the underlying brickwork is flat to start with, the Misco Hearth will remain flat and level until the supporting brickwork itself upheaves or sags. The Misco Flexible Hearth is shockproof and practically indestructible. It will protect the hearth brickwork at temperatures up to 2200°F. Since its adoption our own furnace hearths have

lasted three times as long, and we believe a Misco Flexible Hearth would do the same for you.

For further details and specifications—send your inquiry to Misco.

### WE WILL EXHIBIT

National Metal Exposition  
Booth G 409 Detroit, Michigan  
October 15-19, 1951

## ALLOY CASTING DIVISION Michigan Steel Casting Company



One of the World's Pioneer Producers and Distributors of Heat and Corrosion Resisting Alloys

1998 GUOIN STREET • DETROIT 7, MICHIGAN

OCTOBER 1951; PAGE 213



## where there's heat...

... there's a need for instant, accurate reading of surface temperatures to prevent costly damage to materials in process and equipment.

The handy Alnor Pyrocon is unequalled for quick, accurate reading of surface temperatures of molds, revolving rolls, bearings, steam traps, plastics, metals and many other materials. It's a well balanced, handy instrument that will stand heavy use, yet perform with laboratory precision.

A wide selection of thermocouples and extension arms assures its adaption to your type of service. Send for Bulletin No. 4257. Illinois Testing Laboratories, Inc., Room 523, 420 N. La Salle Street, Chicago 10, Illinois.



**Alnor**

PRECISION INSTRUMENTS  
FOR EVERY INDUSTRY

## Explosion Deformation Tests of Weldments

(Continued from p. 212)

1. Balanced biaxial stress (circular die).

2. Unbalanced biaxial stress (elliptical die) (a) with weld perpendicular to major principal stress (coincident with major axis of die) and (b) with weld parallel to major principal stress (coincident with minor axis of die).

These weldments represent fairly close matching of weld metal and plate flow strengths. In the circular bulge, the presence of the weld produced an unbalanced strain pattern, with the major stress occurring longitudinally in the weld direction. In all cases the strain transverse to the weld is decreased from that observed in the same locations of the unwelded bulge. In the elliptical bulge the strain longitudinally in the direction of the weld is not significantly different from that observed in the unwelded bulge in the same location and direction.

The high-alloy submerged arc (tested with the elliptical die only) welds overmatch the plate by about

43,000 psi. in flow strength. With the weld on the major axis of the die, the strain field of the bulge was completely reversed from that of the unwelded bulge (from 1 to 2 to approximately 3 to 1). With the weld on the minor axis of the die, the strain field of the bulge showed an unbalanced ratio markedly increased (1 to 8) from that of the unwelded bulge (1 to 2). While exact comparisons between the low and high-strength weld metal bulges cannot be made, because of the testing differences, it is interesting to note that the higher strength weld metal caused a greater reduction of strain transverse to the joint from that in the unwelded bulge.

The manual E12016 weldments were tested only with the elliptical die as indicated by 2a and 2b. These weldments represent considerable overmatching of the plate by some 66,000 psi. in flow strength. With the weld on the major axis of the die, the strain field of the bulge indicated a 1 to 1 ratio as compared with a 1 to 2 ratio for the unwelded bulge. With the weld on the minor axis of the die the strain ratio was 1 to 7 as compared with the strain ratio of 1 to 2 for the unwelded

(Continued on p. 216)

## THEY WORK TOGETHER



## TO CUT YOUR CARBURIZING Costs

You save three ways by using Stanwood containers with Stanwood retorts. They go together to give you (1) containers and retorts that match each other perfectly in size and shape; (2) retorts and containers made of the same heat and corrosion resistant materials; and (3) the cost cutting economy of securing all of your needs from a single source. Write today for the cost-cutting Stanwood answer to your particular heat treating problems.

**Stanwood Corporation**

4817 W. Cortland St.

Chicago 39, Ill.



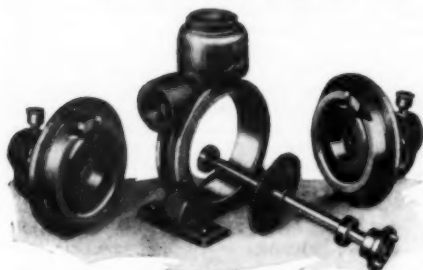
# FAHRALLOY CASTINGS

## for ECONOMICAL HEAT and CORROSION SERVICE

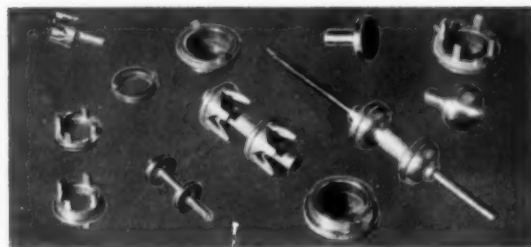
In your constant search for maximum service at lower heat/hour cost why not consider castings by Fahr alloy. The purchaser of Fahr alloy castings of either a heat or corrosion resistant grade is assured a consistently high quality product backed by sound foundry practice and careful laboratory control.

Typical Fahr alloy castings are shown . . . long-time users praise their uniformity and long service life.

### GRADES OF FAHRALLOY FOR HEAT, CORROSION OR A COMBINATION OF BOTH

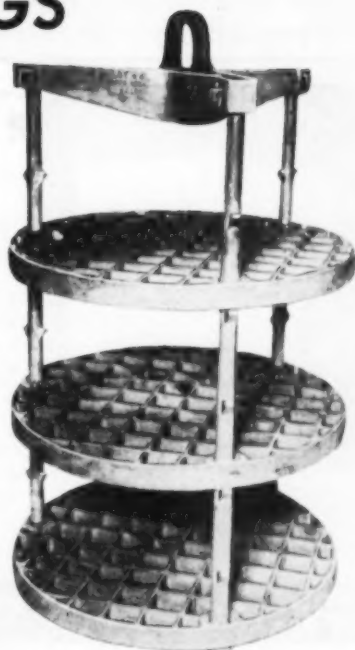


Fahr alloy parts for pump handling hot, corrosive liquids.

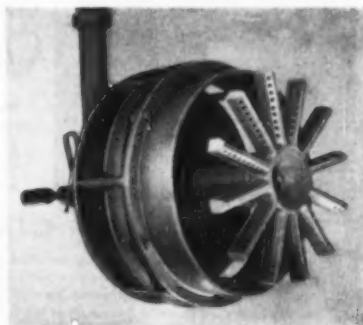


Machined Fahr alloy valve castings for an application involving abrasive wear and corrosion.

### Booth H-151 Metal Show



Fahr alloy fixture for handling parts in heat-treating.



Fahr alloy oil refinery burner subjected to heat and corrosion.

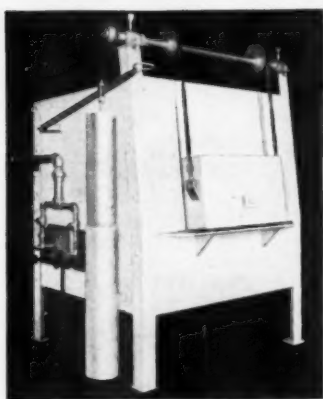
# THE FAHRALLOY COMPANY

CHROMIUM-NICKEL ALLOY CASTINGS FOR  
149th AND LOOMIS, HARVEY, ILL.

In Canada — Fahr alloy Canada, Ltd., Orillia, Ontario

CORROSION  
HEAT  
ABRASION

**for Annealing—Hardening—Drawing  
Carburizing—Normalizing—**



**ROCKWELL  
STANDARD  
OVEN  
FURNACES**

- Oil, gas or electric.
- Wide heating range.
- Simple—rugged—economical.
- Rapid, uniform heating.
- Accurate duplication of heating results.
- Controlled temperature and atmosphere.
- 18 standard sizes.
- May be provided with mufflers, cooling chambers, doors at both ends, etc.

Write for Bulletin 413.

Rockwell builds many types of batch or conveyor furnaces and ovens; strip and wire winding and cleaning machines; handling equipment; non-ferrous rod mills; special fabrications.

**W. S. ROCKWELL COMPANY**  
204 ELIOT STREET • FAIRFIELD, CONN.

## When You Clean Metals...



**Get Rid of the  
Chips, Too!**

Make your cleaning job complete. Remove oils and greases AND chips and solid dirt in one speedy, thorough cleaning operation.

### MAGNUS AJA-DIP CLEANING MACHINES

do a cleaning job that cannot be equalled by degreasers and spray cleaning machines. The batches of parts are vigorously agitated up and down in the cleaning solution 54 times a minute. Turbulent mechanical cleaning action shears and scrubs ALL surfaces, even down in the center of the load, removing chips and solid dirt as the chemical action of the cleaner loosens their bond to the metal and emulsifies the oils and greases. Cleaning is automatic, too. Only one man is needed to do the job.

There's a Magnus Aja-Dip Machine for your production volume. Available from small units for batches of 75 lbs., to machines capable of handling 2200 lbs. per batch. Ask us to recommend the machine and cleaner best suited to your specific operations.

MAGNUS CHEMICAL CO. • 96 South Ave., Garwood, N. J.  
In Canada—Magnus Chemicals, Ltd., Montreal.  
Service representatives in principal cities.



**MAGNUS**  
CLEANERS • EQUIPMENT • METHODS

## Explosion Deformation Tests of Weldments

(Continued from p. 214)

bulge. In both cases the strain along the weld was not significantly different from that of the unwelded bulge in the same location and direction.

Transweld strain reductions were less for the manual weld than for the high-strength submerged arc weld, particularly in view of the fact that the manual multipass single-V weld overmatched the plate in flow strength to such a greater extent than the single-pass high-strength submerged arc weld of square geometry. It is suggested by the authors that this behavior may be accounted for by the difference in geometry of the welded joints.

From the test data the authors deduce that:

1. With overmatching welds in unbalanced biaxial load fields the principal strain reaches (a) a maximum value when the weld is located in the direction of the major stress, and this strain is always along the length of the weld regardless of overmatching characteristics and joint geometry; (b) a minimum value when the weld is located in the direction of the minor stress.

2. With overmatching welds in unbalanced biaxial load fields, the direction of the minimum principal strain varies with overmatching characteristics. Ordinarily, this strain is transverse to the weld but shifts to the longitudinal direction if overmatching characteristics and joint geometry produce sufficient deconcentration to reverse the strain field.

3. Overmatching welds in balanced biaxial load fields will develop highly unbalanced biaxial stress patterns.

The authors also point out that "For uniaxial or strongly unbalanced biaxial loads, it is possible to reduce the value of the principal strain by orienting the weld transverse to the direction of principal load. In the case of balanced loads such manipulation is not possible."

In view of the above data and the deductions offered, it is perhaps unfortunate from the viewpoint of the welding engineer that the undermatching weld is not included. However, there is a very significant possibility, as suggested by the authors, that geometry of the weld may be of greater influence on the stress or strain patterns than overmatching characteristics.

W. L. WARNER

**ANOTHER CHAPTER IN  
THE HISTORY OF LEPEL**

# LepeL's NEW HOME



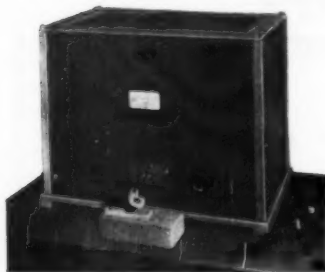
**JUST ACROSS THE EAST RIVER IN WOODSIDE, NEW YORK CITY**

The new building containing our new factory and offices, designed on the most modern architectural lines, reflects the steady gains made by LepeL for a quarter of a century.

The reputation enjoyed by LepeL in the field of Induction Heating equipment has been made possible by the high quality of the LepeL products and the integrity of the LepeL organization with its pleasant customer relationship.



## HIGH FREQUENCY *Induction* HEATING UNITS



### LOW COST 2 KW PORTABLE UNITS

Spark Gap operated on 110 volts



### SPARK GAP CONVERTERS

from 4 kw to 30 kw



### ELECTRONIC TUBE GENERATORS

from 5 kw to 50 kw

**ANY LEPEL UNIT DOES THESE JOBS—**

*faster  
better  
cheaper*



#### HARDENING

Heat localized exactly where wanted, to any desired temperature up to 5000° F.



#### BRAZING

Permits widest choice of copper or silver brazing alloys.



#### MELTING

Readily melts metals and alloys of high melting point.

#### SOLDERING

Heater, faster, without waste or discoloration.



#### ANNEALING STRESS RELIEVING NORMALIZING PRE-HEATING

For Hot Forging, Hot Drawing, etc.



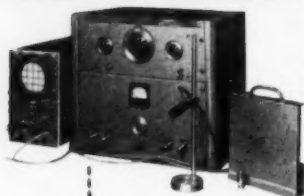
**55th STREET and 37th AVENUE, WOODSIDE 77, NEW YORK CITY, N. Y.**

**Tel. HAVemeyer 6-4580**

**NOW!**  
*measure Young's  
modulus of elasticity*

**BY MEANS  
OF SOUND  
VIBRATIONS**

**Determines Resonant Frequency of  
Any Mass for Structural Strength**



### NEW ELECTRO Sonometer

Easily measures torsional and flexural characteristics of any material or solid mass. The mechanical driver is placed at one end of the sample under test and the pick-up at the other. Power is fed into the driver causing sample to vibrate. The pick-up converts this vibration into electrical energy, and as oscillator is tuned to proper frequency the point of resonance is shown by the meter. Mode of vibration and phase relationship are viewed on a cathode ray oscillograph.

#### For Testing

Aluminum  
Carbon  
Electrodes  
Castings  
Concrete  
Ceramics  
Pressed  
Materials  
Plastics  
Metal  
Wood  
Many  
Others

Send Coupon Today for Detailed Bulletin

**ELECTRO PRODUCTS LABORATORIES**  
4501-MP Ravenswood Ave., Chicago 40, Ill.

Name \_\_\_\_\_

Firm \_\_\_\_\_

Street \_\_\_\_\_

City \_\_\_\_\_

State \_\_\_\_\_

Precision Instruments Since 1944



**Makers of the  
DYNAMIC  
MICROMETER**

Measures dynamic or static displacement of any metal body without physical contact.

SALES ENGINEERS IN PRINCIPAL CITIES

## Steel in India

(Starts on p. 93)

major iron and steel producers, the deposits in Orissa and Madhya Pradesh are important. The former are within 110 to 200 miles from the major producers and the latter about 550 miles away. Ores are generally of medium phosphorus content, but as there is very little low-phosphorus coking coal, Indian ferromanganese is higher in phosphorus than the foreign product.

Though very little effort has so far been made to estimate the size of Indian manganese deposits, it can be safely said that they are sufficient for internal consumption with a moderate exportable surplus.

#### CHROMITE

Chromite is used as an alloying element as well as a refractory. High-grade ores are used for the former, since ferrochromium is not manufactured in India at present. Chromite is being mined at Nuasahi in Orissa State, Chaibassa in Bihar, and in Mysore. The Chaibassa deposits, the nearest to the steel plants, are in an open pit which has now

reached an uneconomic stage of working. Location of extensions of old lodes and new lodes by geophysical prospecting and diamond drilling is necessary.

The Orissa deposit is the richest in quality of the ore so far found in the Indian Union. Unfortunately, no attempt has been made to prospect the body or to work it scientifically. The Mysore deposits are close to the Mysore Steel Works and supply all their requirements.

We can safely say that total reserves are extremely limited and their export should be restricted or stopped altogether.

#### MINOR ALLOYS AND REFRACTORIES

No commercially workable deposits of tungsten, nickel or molybdenum have been found, and the present consumption is so small that any mining would have to depend on exports. Vanadium (2.5%  $V_2O_5$ ) is found associated with titanium in extensive iron ore deposits in the states of Bihar and Orissa; considerable experimental work has been done on the concentration of these ores.

While India is favorably endowed  
(Continued on p. 220)

# REFRACTORIES

**Meeting Today's  
Higher Temperatures**

## PORCELAIN TUBES

FOR

- COMBUSTION
- PYROMETRY
- INSULATION
- HEAT TREATMENT

For Service to 3092° F  
1700° C

## PURE OXIDE CRUCIBLES

FOR

- PROCESS AND
- RESEARCH
- IN CRYSTALLIZED
- ALUMINA

For Service to 3542° F  
1950° C

# A MORGAN PRODUCT

PROVEN PRODUCTS FOR NEARLY A CENTURY

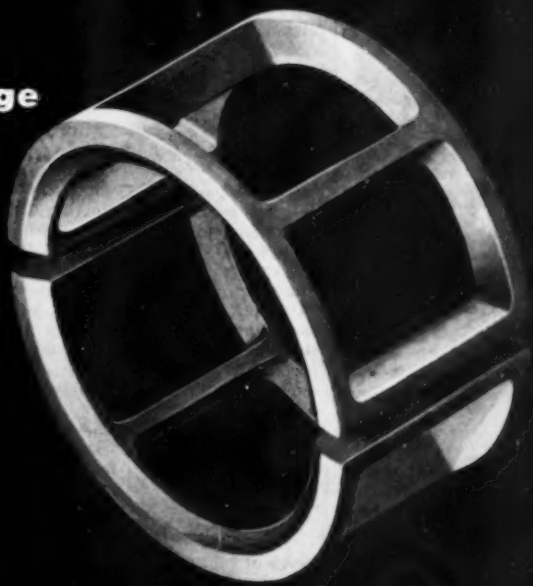
Your Inquiries Invited

## MORGANITE INCORPORATED

3302-3320 43rd AVENUE • LONG ISLAND CITY 1, NEW YORK



**A  
bearings-cage  
that  
forest  
giants  
can't  
wear  
out**



## IT'S MADE OF **BERYLCO** BERYLLIUM COPPER

Ever see a giant fir felled by a chip-spitting mighty mite of a chain saw? All-weather production tools, chain saws have to be dependable, tough... and light. A lumber-jack doesn't want to heft 100 pounds around all day if 50 will do the job.

McCulloch Motors shaved a pound off this figure in developing its two-man 5 hp saw and took full advantage of the unique properties of Berylco Beryllium Copper.

The roller bearing units which join connecting rod and crankshaft of this single-cylinder 2-cycle engine are held in place by two cage sections, each half holding nine rollers. The

cage must withstand the punishing action of the rollers as well as the wear and thrust of the hardened steel crankshaft. Many materials were tested for this exacting application, but only Berylco could deliver the required combination of wear resistance, hardness and ductility.

The unique properties of this versatile alloy—its combination of great strength, electrical conductivity and resistance to corrosion—are as vital in the products of defense as they are in peacetime products. We invite you, in your plans for the future, to take advantage of the technical knowledge of the world's largest producer of beryllium copper.

Tomorrow's products are planned today  
—with Berylco Beryllium Copper.

Sample material available  
for testing purposes

### HELPFUL ENGINEERING INFORMATION

is available to you in our monthly technical bulletins. If you would like to be on the mailing list, simply write us on your business letterhead.



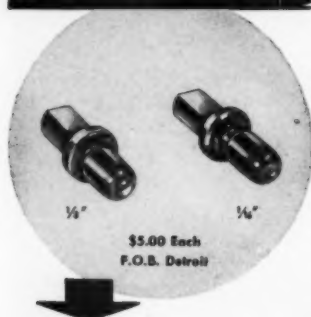
THE **BERYLLIUM** CORPORATION

DEPT. 1J, READING 9, PENNSYLVANIA

New York • Springfield, Mass. • Cleveland • Dayton • Detroit • Chicago • Minneapolis • St. Louis • Seattle • San Francisco • Los Angeles  
Representatives in principal world-trade centers

OCTOBER 1951; PAGE 219

# FOR GREATER HARDNESS TESTER ACCURACY... SPECIFY CLARK STEEL BALL PENETRATORS



For dependably accurate hardness testing, every part of your testing equipment must be designed by experts. CLARK Hardened Steel Ball Penetrators are designed to give the most accurate possible results in the testing of soft metals such as unhardened steel, cast iron, brass, bronze, and similar metals and alloys. They are available in 1/16" and 1/8" diameters at \$5.00, and in 1/4", 1/2", 3/4" and 1" diameters at slightly higher prices. Specify CLARK Steel Ball Penetrators for more accurate "Rockwell" testing.

**CLARK**  
FABRICATING & ALLOY STEEL

**INSTRUMENT, INC.**  
10200 Ford Road • Dearborn, Michigan

## Steel in India

(Starts on p. 93)

with fireclays, and the best are associated with coal measures, production to close specification has never been attempted.

Summarizing the situation in raw materials, and keeping in view an expansion of the industry, India has a marginable surplus of iron and manganese ores for export. We should try to estimate the reserves of our manganese ores and fix the export quota, but we can easily work some very large iron deposits for export only. In the distant future, even if we manufacture 25,000,000 tons of steel per year, our consumption of iron ore will be about 50,000,000 tons and of manganese ore 1,200,000 tons. Our resources in these two are ample for an indefinite time. However, attention must be paid to cheap bulk mining, and the preparation and standardization of raw materials.

### FUTURE OF INDIAN STEEL INDUSTRY

The great disparity in the reserves of high-grade iron ores and coking coals puts a limitation to the production of iron in blast furnaces. Consequently, the pattern of the future iron and steel industry in India will be different from that in any other country. Near the coal fields, until the reserves of coking coal are exhausted, we will have to run ordinary blast furnaces. Where cheap electricity is available, we will have to use the Tysland-Hole electric furnace. (The first one of its kind is nearing completion at Mysore.) We should also try the Krupp-Renn, Stuerzelberger\* and low shaft furnaces which do not require coking coal, since we have reasonable reserves of noncoking coal. It may also be advisable to set up small units for the production of charcoal pig for high-class steels.

The use of the different processes will depend on the regional advantages of each. A balanced, over-all planning, keeping in view stark realities, will be necessary to make the best use of our resources.

The Government of India had planned to build two integrated steel plants of 500,000 tons capacity in the postwar industrialization

(Continued on p. 222)

\*The Krupp-Renn process reduces a mixture of fine ore and coal in a rotating furnace like a cement kiln. The Stuerzelberger furnace is similar in principle, but its axis is not fixed; operating as a batch-type process the furnace can be tilted to any safe angle for charging or discharging.

## Tempilstiks®

*The amazing  
Crayons  
that tell  
temperatures*



A simple method of controlling temperatures in:

- WELDING
- FLAME-CUTTING
- TEMPERING
- FORGING
- CASTING
- MOLDING
- DRAWING
- STRAIGHTENING
- HEAT-TREATING
- IN GENERAL

Also available in pellet and liquid form

It's this simple: Select the Tempilstik® for the working temperature you want. Mark your workpiece with it. When the Tempilstik® mark melts, the specified temperature has been reached.

**\$2**  
each

gives up to 2000 readings

Available in these temperatures (°F)

113	263	400	950	1500
125	275	450	1000	1550
138	288	500	1050	1600
150	300	550	1100	1650
163	313	600	1150	1700
175	325	650	1200	1750
188	338	700	1250	1800
200	350	750	1300	1850
213	363	800	1350	1900
225	375	850	1400	1950
238	388	900	1450	2000

**FREE** —Tempil® "Basic Guide to Ferrous Metallurgy" — 16 1/2" by 21" plastic-laminated wall chart in color. Send for sample pellets, stating temperature of interest to you.

**GORDON SERVICE**

**CLAUDE S. GORDON CO.**

Manufacturers & Distributors

Thermocouple Supplies • Industrial Furnaces & Ovens  
Pyrometers & Controls • Metallurgical Testing Machines  
Dept. 15 • 3000 South Wallace St., Chicago 16, Ill.  
Dept. 15 • 2035 Hamilton Ave., Cleveland 14, Ohio



# Metallurgical TESTING EQUIPMENT

**Designed for Speed  
and Accuracy**

**Will be displayed in  
Bldg. B**

**Booth B 131**

**Michigan State Fairgrounds  
Detroit, Michigan**

**October 15-19**

The Buehler Ltd. line includes complete equipment for the preparation of metallurgical samples for examination under the microscope. Several machines from the following list of products will be in operation.

The Buehler line of Specimen Preparation Equipment includes—Cut-Off Machines • Specimen Mount Presses • Power Grinders • Emery Paper Grinders • Hand Grinders • Belt Surfacers • Mechanical and Electro Polishers • Polishing Cloths • Polishing Abrasives.

Equipment in operation for your inspection will include the new Buehler Speed Press which will increase your output of mounted samples by 200%, new cut-off machines, mechanical and electrolytic polishers, grinders, metallographs, microscopes and other metallurgical apparatus.

*Adolph J. Buehler ★ Buehler Ltd.*



**OPTICAL INSTRUMENTS**

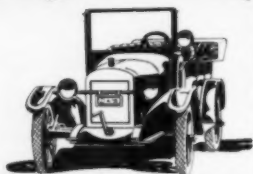
**228 NORTH LA SALLE STREET  
CHICAGO 1, ILLINOIS**

**METALLURGICAL APPARATUS**

**165 WEST WACKER DRIVE  
CHICAGO 1, ILLINOIS**



*Since 1914*



**A TRIED and PROVEN  
SOURCE FOR**

## TESTING MACHINES

**BRINELL  
DUCTILITY  
COMPRESSION  
TENSILE  
UNIVERSAL  
TRANSVERSE  
HYDROSTATIC  
PROVING INSTRUMENTS**

and  
Special Testing Machines built  
to your Specifications.

*Send for  
this  
Brochure*



*Steel City  
Testing Machines Inc.*

8835 Livernois • Detroit 4, Mich.

Without obligation send me your brochure  
on testing instruments. Also special folders on  
following types (check your interest):

- |  |                                      |
|--|--------------------------------------|
| <input type="checkbox"/> Brinell Hardness    | <input type="checkbox"/> Ductility   |
| <input type="checkbox"/> Compression         | <input type="checkbox"/> Tensile     |
| <input type="checkbox"/> Transverse          | <input type="checkbox"/> Hydrostatic |
| <input type="checkbox"/> Proving Instruments |                                      |

NAME \_\_\_\_\_

TITLE \_\_\_\_\_

Attach coupon to your letterhead  
and mail

Metal Show Booth No. G-220

## Steel in India

(Continued from p. 220)

scheme. Each of the plants was estimated to cost about 1000 million rupees (\$210,000,000). However, the Government, with its high commitments on the river valley projects, did not make the necessary appropriations and, as outside capital was not available, these plans have been shelved temporarily. This "steel plan" intended to nationalize this basic industry after running the newly built plants for a decade. The industry in this country is already controlled, in a way, since the wartime Iron and Steel Control has become a permanent feature, wherein the selling price of steel and its distribution are controlled by the Government. Discussions on this subject have so far been conducted in very general terms, and have not come down to the specific point of the degree of benefit to be derived from such capital expenditures and nationalization.

At present the Government is loaning money to the three major operators to renovate and expand their facilities. The over-all increase in steel production will be about 400,000 to 500,000 tons per annum (about one third present capacity).

In conclusion it may be said that the prospects of our iron and steel industry are very encouraging. India has great future economic possibilities, an abundance of raw materials, huge population, and potential markets. Even the limited reserves of coking coal need not worry us if properly utilized. The Government has been committed to a policy of industrialization and the fundamental importance of such a basic and important industry cannot be overemphasized.

India is singularly well placed to support an integrated industry. While Europe as a whole is self-sufficient in coal and scrap, and largely though not entirely independent as regards iron ore, individual countries are in a different position; the striking feature is their interdependence for the principal raw materials.

Consequently, future expansion in India must face two special difficulties. The first is our complete dependence on the western countries for capital goods. The second is the problem of finance. That we can overcome both these difficulties will depend on how much free enterprise is allowed to play its part in future developments, our fiscal policy, the cooperation of labor.

(Ends on p. 224)

## **Sperry** REFLECTOSCOPE SAVES TIME MATERIAL MONEY

WRITE  
FOR  
BOOKLET  
TODAY



## PUT SOUND TO WORK

**DETECT  
INTERNAL FLAWS  
IN METALS**

*at Low Cost*

Ultrasonic vibrations penetrate up to 30 feet to "see" internal defects and fatigue cracks in primary metals and finished metal parts. TEST NEW MATERIAL at the mill to improve quality and customer acceptance. TEST METALS PRIOR TO PROCESSING, MACHINING AND FABRICATING to avoid wasted time and man-hours resulting from faulty materials. QUALITY CONTROL of work in process. MAINTENANCE INSPECTION to detect fatigue fractures. MEASURE PHYSICAL DIMENSIONS. You can detect internal flaws more effectively at lower cost with a Reflectoscope . . . for sale, for rent, for lease. Inquire today. Protect and improve your reputation for products of fine quality—eliminate service failures.

**SPERRY Products, Inc.**  
Danbury, Connecticut

MANUFACTURERS OF  
METAL TESTING EQUIPMENT  
HYDRAULIC CONTROLS  
SELF-SEALING COUPLINGS  
LITERATURE ON REQUEST



## OLD FRIENDS...

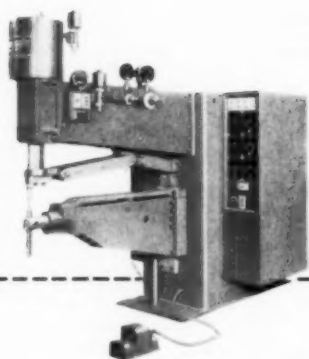
### SCIAYK WELDERS

LEAD THE FIELD IN MEETING  
MILITARY WELDING SPECIFICATIONS

NINETY-FIVE per cent of all resistance welding to MIL-6860 and MIL-6858 Air Force-Navy Specifications is done on SCIAYK machines — PROOF of know-how . . . PROOF of high quality welding . . . PROOF of production. This fact is your guarantee of satisfaction.

Today, the new SCIAYK Series PMCO ST Three-Phase Welders offer new benefits to the aircraft industry and others welding aluminum, magnesium, brass, monel, inconel, stainless, super stainless, heat-resisting alloys and others. Each machine in this series is quickly adjustable to handle them all! Quality of welds is unequalled. Tip life is increased as much as 300%.

Sciaky guarantees to qualify the PMCO ST Welder to MIL Specifications at the time of installation in your plant. Write today for complete data on the welder that is the "Standard" for the aircraft industry.



#### PMCO ST Series Resistance Welders

THIS series employs the patented Three-Phase Principle invented and brought to highest efficiency by Sciaky. This system offers many advantages over the conventional single phase welders. Among them:

- Balanced three phase load
- KVA demand reduced 75% or more
- Near unity power factor
- Versatility
- Speed

#### Send for Bulletins

Complete data on machines for ferrous and non-ferrous welding available on request. For specific information, write today, outlining your requirements.



**SCIAYK**  
SAY "SEE-ACKY"

### SCIAYK BROTHERS, INC.

4933 W. 67th Street, Chicago 38, Illinois



# 6 to 1

**ONE Indicator Plug  
Connects to any of  
SIX Thermocouple Jacks**

**MULTI-POINT  
PYROMETER  
INDICATOR**

**Fast Simple Versatile  
Compact Trouble-Free**



Designed to indicate temperatures for various applications.

Indicator is automatically compensated for cold junction temperature changes and instrument temperature resistance coefficient.

Available in five temperature ranges, either Fahrenheit or Centigrade.

Maximum accuracy is obtained because Polarized Plugs and Jacks are of thermocouple materials, eliminating errors produced by unmatched elements.

The coupling plug quickly connects the pyrometer to any of the six thermocouple jacks.

If you will advise us the details of your application, we will recommend suitable equipment or, for additional information request our Catalog Section 25 H

**Thermo ELECTRIC CO.**  
FAIR LAWN, N.J.



**CONTROLLED  
QUALITY**

**COMPLETE  
STOCKS**

**PROMPT  
ACCURATE  
SERVICE!**

**WYCKOFF STEEL COMPANY**

FIRST NATIONAL BANK BUILDING PITTSBURGH 30, PA.  
3200 S. KIDZIE AVENUE CHICAGO 23, ILLINOIS  
Works at: Ambridge, Pa., Chicago, Ill., Newark, N.J., Putnam, Conn.

and a deep study of all factors for the future industrialization of the country.

## References

on Aluminum Bearings

(Starts on p. 97)

1. "Aluminum Alloys for Bearings", by H. Y. Hunsicker and L. W. Kempf, *Quarterly Transactions of the Society of Automotive Engineers*, V. 1, January 1947, p. 6 to 29.
2. "High-Output Aircraft Engines", by E. W. Hives and F. L. Smith, *Transactions of the Society of Automotive Engineers*, V. 35, 1940, p. 106 to 118.
3. "Aluminum Alloy Bearings—Metallurgy, Design and Service Characteristics", by H. Y. Hunsicker, *Sleeve Bearing Metals*, American Society for Metals, 1949, p. 82 to 118.
4. "The Aluminum-Tin Phase Diagram and the Characteristics of Aluminum Alloys Containing Tin as an Alloying Element", by A. H. Sully, H. K. Hardy, and T. J. Heal, *Journal of the Institute of Metals*, V. 76, 1949-1950, p. 269 to 294.
5. "Studies of Interface Energies in Some Aluminum and Copper Alloys", by K. K. Ikeuye and Cyril S. Smith, *Journal of Metals (Transactions Section)*, V. 1; *Transactions of the American Institute of Mining and Metallurgical Engineers*, V. 185, 1949, p. 762 to 768.
6. "Dendritic Crystallization of Alloys", by B. H. Alexander and F. N. Rhines, *Journal of Metals*, V. 188, October 1950; *Transactions of the American Institute of Mining and Metallurgical Engineers*, V. 188, 1950, p. 1267 to 1273.
7. "Discussion—Institute of Metals Division; New York Meeting, February 1950. 'Undercooling of Minor Liquid Phases in Binary Alloys'", by C. C. Wang and C. S. Smith, *Journal of Metals*, V. 188, November 1950; *Transactions of the American Institute of Mining and Metallurgical Engineers*, V. 188, 1950, p. 1353 to 1381.
8. "The Effect of Small Quantities of Cd, In, Sn, Sb, Ti, Pb or Bi on the Aging Characteristics of Cast and Heat Treated Aluminum, 4% Copper, 0.15% Titanium Alloy", by H. K. Hardy, *Journal of the Institute of Metals*, V. 78, 1950-1951, p. 169 to 194.
9. British Non-Ferrous Metals Research Association, *Research Reports Association Series No. 792*, June 1948, by J. McKeown and L. N. Back.



#### **ASSURED SUPPLY FOR**

#### **321 STAINLESS** Alloys of Titanium used in making Type 321

Stainless Steel are produced by TAM from North American Ores assuring continuous supply. Economic advantages spotlight increasing attention to excellent high temperature properties and other outstanding features. Complete technical data on request. Write our New York Office.

\*TAM is a registered trademark.



#### **TITANIUM ALLOY MFG. DIVISION** **NATIONAL LEAD COMPANY**

Executive and Sales Offices: 111 BROADWAY, NEW YORK CITY  
General Offices, Works and Research Laboratories: NIAGARA FALLS, N. Y.

## Gaseous Annealing of Black-Heart Malleable Iron\*

**G**ASEOUS ANNEALING of black-heart malleable iron in controlled atmospheres is easily and conveniently done in furnaces well sealed to prevent infiltration of air or flue gases. A suitable atmosphere soon results from the interaction of the carbon in the castings and the residual air. Poor furnace seals lead to badly decarburized and pearlitic rims in the annealed castings. If

additional atmosphere is deemed necessary, it must not contain more than 3%  $H_2$  and very little water vapor, since hydrogen in greater amounts will retard the graphitizing reaction.

For British irons of 2.30 to 2.50% C and 0.90 to 1.10% Si, a typical annealing cycle for black-heart malleable might be 40 to 70 hr. divided as follows: (a) Heating up to top soaking temperature for 9 to 12 hr. (slow heating between 700 and 1100° F. to induce maximum nodule number for accelerated graphitizing rate); (b) Primary graphitization of massive carbide

at 1650 to 1700° F. for 15 to 30 hr.; (c) Cooling to just above critical range (1400° F.) at 100° F. per hr. for 3 to 5 hr.; (d) Slow controlled cooling to effect secondary graphitization through and below critical range (1400 to 1300° F.) at 4 to 9° F. per hr. for 12 to 24 hr.; (e) Final cooling to room temperature, rate not important.

### Furnaces for Gaseous Annealing

— No matter what type of furnace is used, it must be sealed against uncontrolled entry of air or flue gases. This can be achieved in practice on large furnaces only by the use of electric resistor units or radiant heating tubes, the particular choice being made largely on the basis of over-all economy.

Continuous furnaces for black-heart annealing are usually straight through tunnel-type, with the length subdivided into the different temperature zones required to effect the proper time-temperature cycle. The work is carried through on a suitable conveyer, of which the pusher-tray type is the simplest and of lowest first cost. Continuous furnaces are most adapted to large tonnages of a constant product, are less flexible for varying load and product than intermittent-type furnaces and so have been little favored by British foundrymen.

Batch-type furnaces that can be easily adapted to gaseous annealing are of four basic types:

1. Horizontal end-charged batch-type loaded with a charging machine.
2. Horizontal car-type hearth.
3. Elevator-type with fixed furnaces mounted above floor level and transportable car-type hearth.
4. Bell or lift-off type with fixed hearth and movable furnace.

The last two types are most easily rendered gas-tight. Castings can be loaded fairly densely in such furnaces, while small castings are usually placed in alloy baskets. Reasonable temperature uniformity is required, especially during the second stage of the graphitizing cycle, which may be obtained by proper subdivision of the heating elements and a programmed temperature cycle.

If electric resistors are used, forced cooling is obtained by means of tubes mounted in the furnace in-

(Continued on p. 228)

# 'ROUND-THE-CLOCK PRODUCTION!



➡

## OVENS

Batch-Conveyorized.  
Oil-Gas-Steam-Electric Heated.

➡

## WASHERS

Monorail-Belt Type • Straight Line-Rotary-U-shaped  
Oil-Gas-Steam • Electric Heated.

➡

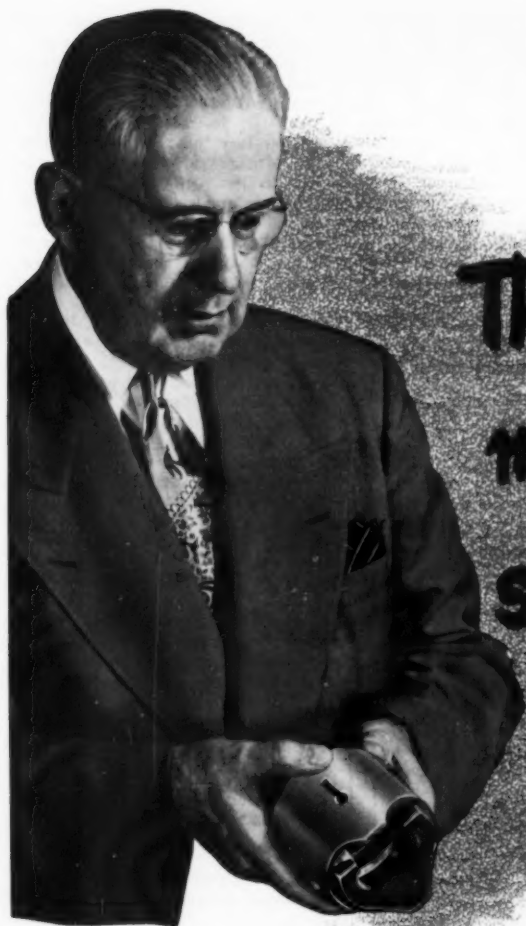
## SPRAY BOOTHS

For manual or automatic spraying • All sizes and arrangements • Also, Dip Tanks and Flo-casting Machines.

# peters-dalton Inc.

17932 RYAN ROAD • DETROIT 12, MICHIGAN

\*Abstract of "Gaseous Annealing of Malleable Castings: The Present Position, Part II — Black-Heart Malleable", by P. F. Hancock, *Journal of Research and Development, British Cast Iron Research Association*, Vol. 3, April 1951, p. 913-922.



#### ANOTHER THOMPSON DEVELOPMENT

*Three ring controlled aluminum pistons for high compression engines with scalloped skirt.*

**Thompson packs  
more power into  
smaller packages**

**N**EW opportunities for cutting costs of intricate parts are being opened up by Thompson Products' advanced developments in casting light metals in permanent mold and high pressure dies. In many fields, ferrous castings are being replaced by more efficient light alloys of aluminum and magnesium. Records show resulting benefits to industry to stronger, more durable products requiring considerably less machining and finishing, and better heat conductivity. Through Thompson's unique developments in quality control and moulding methods, dependable uniformity from

piece to piece is eliminating costly scrap losses.

Thompson's creative engineers will gladly put their many years of experience to work for you by showing where and how you, too, can simplify your operations with light metals and save on costs. Simply write Thompson Products, Inc., Light Metals Division, 2269 Ashland Road, Cleveland 3, Ohio.

## Thompson Products

**LIGHT METALS DIVISION**  
2269 Ashland Road • Cleveland 3, Ohio

*Other Examples of How Thompson Light Metals Serve Industry: End Frames for Fractional Horsepower Motors, Housings for Garbage Disposal Units, Fan Blades for Industrial Ventilators, Fluid Drives for Automotive Transmissions, Bazookas for Army Ordinance*

## Gaseous Annealing of Black-Heart Malleable Iron

(Continued from p. 226)

terior through which air is blown during the cooling cycle. With radiant tube furnaces it is necessary to merely shut off the fuel flow and blow air through the tubes.

The bell or lift-off furnace is quite similar in construction and operation to the elevator-type except that the hearths are fixed units at floor level, while the furnace is movable by an overhead crane.

**Two-Furnace System** — The heating up and soaking period necessary to complete first-stage graphitization is roughly equal to the time required to cool and complete second-stage graphitization. Because of this, it is sometimes economical with elevator or bell-type furnaces to operate them in pairs, with one furnace maintained at high temperature while the other is used for the low-temperature slow cool. Three hearths are required for this method of operating: one hearth heating in the high-temperature furnace, a second cooling in

the low-temperature furnace, with a third being unloaded or reloaded.

If the heating up and soaking period is longer than the time required for second-stage graphitization, it is desirable to use the low-temperature furnace for preheating the new charge before it enters the high-temperature furnace.

There are various advantages to be gained from the two-furnace system. Since both furnaces operate at a nearly constant temperature, there is no energy wasted in heating or cooling brickwork (with a possible saving between 10 and 20% in heating energy) and less wear and tear on refractories. Also, each furnace can be particularly adapted to its function. The low-temperature furnace alone need be equipped with a cooling system. Since this furnace never operates above 1400° F., high-speed circulating fans to promote uniformity of heating and cooling may be incorporated. Finally, there is no risk of recarburizing the surface of the castings, since the atmosphere in this low-temperature furnace can never develop a high CO content.

**Electric Elevator Furnace Installation** — Since, at present, there is no black-heart foundry in Great Britain operating elevator-type furnaces, it is necessary to obtain operating data from a modern American foundry in Ohio. Here six pairs of electric furnaces using the two-furnace cycle anneal up to 100 tons per day of castings ranging in weight from  $\frac{3}{4}$  to 375 lb. New charges are loaded directly into the high-temperature furnace, and upon completion of this stage to the low-temperature furnace.

Over-all annealing cycle will range from 40 to 60 hr. for an iron of 2.40 to 2.50% C and 1.20 to 1.30% Si. Power consumption averages 375 kw-hr. per ton, maintenance costs are very low, and no heating elements or furnace components have required replacement in 4 years. The cost of the expendable alloy baskets which hold the castings during annealing is about \$1.00 per ton.

**Gas-Fired Bell Furnace Installation** — A number of large gas-fired bell furnaces have been in operation at a British black-heart foundry for about a year. These furnaces are heated by vertical radiant tubes and hold about 25 tons of automotive castings which are self stacking. The entire annealing cycle takes place in the same furnace, requiring 85 hr. for an iron of 0.95 to 1.05% Si content.

C. H. JUNGE

## GALILEO

### CONTOUR MEASURING PROJECTOR

Measures, Compares, Inspects  
and Photographs the contours  
and surfaces of mechanical parts.

Be sure to see the  
Galileo line of

HARDNESS TESTERS,  
normal and  
superficial

OPTICAL  
COMPARATORS

EXTENSOMETERS

METAL POLISHERS

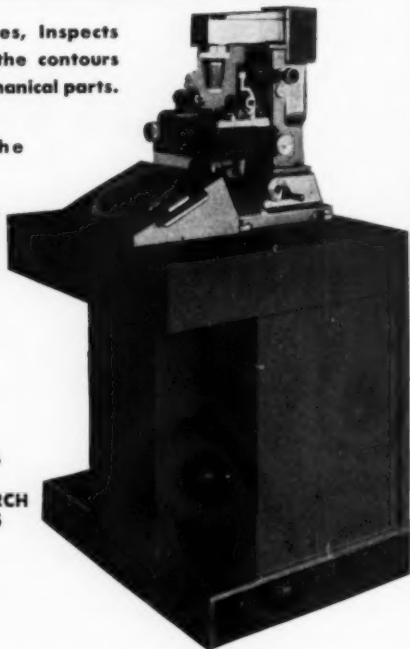
PORTABLE  
METALLOGRAPHS

UNIVERSAL RESEARCH  
METALLOGRAPHS

TOOLMAKERS  
MICROSCOPES

STEREOSCOPIC  
MICROSCOPES

LATHE MICROSCOPES



See us at Booth B-138  
Building B

The wraps come off four new models for the first time at  
the Show.

Galileo Instruments have been  
used the world over since 1875

Imported and serviced by:

Opplum Company, Inc.  
332 Fourth Avenue  
New York 10, N.Y.

Midwest area:

Metallurgical Instrument Co.  
2434 W. 38th Street  
Chicago 32, Illinois



# MAGNESIUM

## *and the problem of* **FABRICATION**



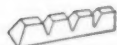
*in your product*

Today American industry is constantly searching for ways to lighten the unprecedented load on its production facilities. Progressive manufacturers have discovered that magnesium... with its combination of lightness, strength and workability... is one answer. These characteristics of magnesium can result in simplified design, speedier fabrication and lowered production costs.

Manufacturers find that magnesium is produced in all common forms including castings, forgings, extrusions and sheet. They learn that it can be machined at

the highest possible speeds of standard machine tools... can be formed by drawing, spinning, bending, stretching and other common production methods. Also that the metal is joined by arc, gas, and spot welding as well as by riveting and is finished by accepted methods.

So if you are making, or contemplate making, anything in which lightness or ease of fabrication is important, plan with magnesium. It has made many products better—more versatile, easier to handle, more profitable to sell—it may improve yours.



*For Your "Tomorrow's" Product . . .*

Today, magnesium is a tremendously important part of our defense effort, and like many other metals, is required in great quantities by the government. But in planning "Tomorrow's" production, remember this fact: the seas, at our own shores can provide 100 million tons of magnesium per year for 1,000,000 years without significantly reducing the supply!

### **THE DOW CHEMICAL COMPANY.**

*Magnesium Department • Midland, Michigan*

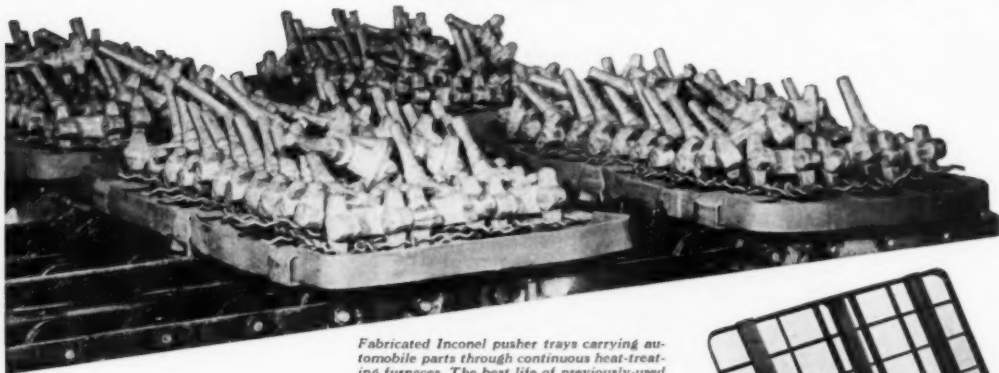
New York • Boston • Philadelphia • Washington • Atlanta • Cleveland • Detroit • Chicago • St. Louis  
Houston • San Francisco • Los Angeles • Seattle • Dow Chemical of Canada, Limited, Toronto, Canada



# Meet a LIGHT-WEIGHT champion..

## Inconel pusher trays

still going strong on a job that  
licked heavier furnace trays!



*Fabricated Inconel pusher trays carrying automobile parts through continuous heat-treating furnaces. The best life of previously-used trays averaged nine months. The fabricated Inconel trays have been in use over one year.*

- Furnace production increased
- Tray life increased
- Maintenance costs reduced

*Inconel pusher tray designed and fabricated by BROWN-HUTCHINSON IRON WORKS, Detroit, Michigan.*



These substantial benefits are what a large automobile manufacturer gained by switching to fabricated Inconel® pusher furnace trays.

Previously-used trays weighed from 114 to 198 pounds each. The fabricated Inconel trays weigh only 86 pounds...a weight saving 28 to 112 lbs. per tray. Based on average net load of 400 pounds this represents a gross weight saving of 5 to 19% over previous equipment.

Even more important—these lighter-weight fabricated Inconel trays last longer, with correspondingly reduced replacement and maintenance costs.

This fine performance record is even more remarkable when the severity of service conditions are considered. During the heat-treating of automobile parts, the trays are subjected to temperatures as high as 1650° F., followed by oil quenching.

The furnaces, which are gas-fired and non-atmosphere in type, present high-temperature corrosion problems. Add to these punishing conditions the considerable mechanical forces acting on the trays...up to 540 pounds load plus 2000 pounds thrust from the hydraulic pusher mechanism...and you have service conditions that demand Inconel plus good fixture design.

Brown-Hutchinson Iron Works are designers and fabricators of these pusher trays. They, like other leading fabricators, used Inconel because of Inconel's outstanding performance record and desirable combination of physical characteristics...thermal durability, corrosion-resistance, high hot and cold strength, workability, economy.

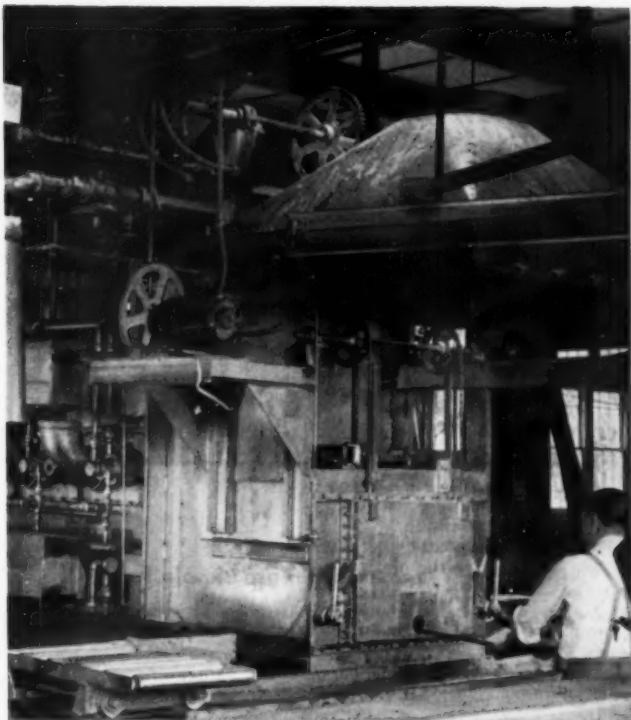
Right now you may not be able to get all the Inconel you want because so much is being diverted to defense work. But if you have a special high-temperature metal problem, Inco's High-Temperature Engineers will be glad to help you.

\*Reg. U. S. Pat. Off.



**The International Nickel Company, Inc.**  
67 Wall Street, New York 5, N. Y.

# **INCONEL\***...for long life at high temperatures



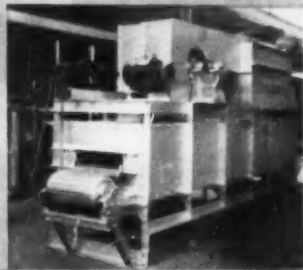
See this new **650** direct-fired controlled atmosphere furnace at the Metal Show—Booth D-320—or write for new descriptive bulletin.

# **NOW... "CIRC-AIR 650"**

**OFFERS THE GREATEST ADVANCE  
IN CONTROLLED ATMOSPHERE  
FURNACE DESIGN**

Circ-Air heat treating furnaces for every heat treating process are specially engineered for your particular needs—gas, oil or electric. Plan your visit to the Metal Show with the Industrial Heating Equipment Company in mind—or write now for assistance on your heat treating problem.

This **draw** furnace will be still another feature you will want to see at the Metal Show—write for illustrated folder outlining the many advantages of this unit.



**Industrial Heating Equipment Co.**

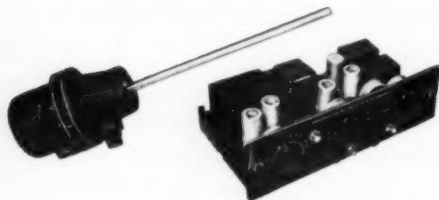
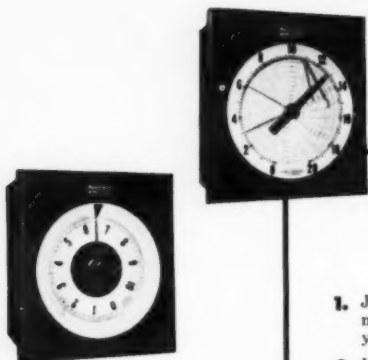
3570 Fremont Place

Detroit 7, Michigan

*Manufacturers of Industrial Furnaces Since 1917*

# 6 things to remember

## WHEN YOU BUY AN



### When you buy instruments, remember these simple facts:

1. Just as insufficient instrumentation is uneconomical, so is instrumentation that is too expensive or too complicated in relation to your furnace or process requirements.
2. Various types and makes of furnaces, and various processes, usually require distinctly different types of instrumentation.
3. No single group of instruments—such as potentiometers, millivoltmeters, thermometers, or non-indicating controls can meet all requirements—any more than can a single type of control action.
4. Your equipment, your process, should determine the type and amount of instrumentation you need. Select the instrument or control system that *exactly meets your requirements*.
5. Wherever possible, use instruments that will enable you to centralize responsibility and service with a single source of supply.
6. A careful selection of your instrumentation will pay you increased dividends in lower operating costs and greater efficiency.

POTENTIOMETERS  
MILLIVOLTMETER PYROMETERS  
RADIATION PYROMETERS  
THERMOMETERS  
PRESSURE GAUGES

FLOW METERS  
LIQUID LEVEL METERS  
REMOTE TRANSMISSION SYSTEMS  
TIME PATTERN CONTROL SYSTEMS  
COMBUSTION SAFEGUARD SYSTEMS

EXCESS TEMPERATURE SAFETY CUT-OFFS  
ELECTRIC PROPORTIONING RELAYS  
ELECTRIC-PNEUMATIC RELAYS  
THERMOCOUPLES  
RESISTANCE BULBS

*Indicating • Non-Indicating • Recording • Controlling (electric or pneumatic)*

## INSTRUMENT OR CONTROL SYSTEM

INSTRUMENTATION for a process can be simple or complex. It can involve a few dollars or a considerable investment. Your selection of instrumentation carries not only the responsibility for the operating efficiency of your plant, but also determines whether your investment will be amortized quickly or over a long term.

To help you get maximum operating efficiency with the quickest return on your investment, Honeywell makes available the world's most complete line of industrial instrumentation. Honeywell's engineers are qualified through *personal* experience in the industry to help you select the right instrument or system for your needs.

### Honeywell offers you these exclusive advantages:

- Complete line assures you of unbiased recommendations.
- Centralizes responsibility with a single source of supply.
- Simplifies maintenance or servicing when required.
- Provides the right instrument or control system to enable you to operate with the maximum of economy and efficiency.

Illustrated are a few of the many instruments and controls made for the metals industries by Honeywell . . . world leader in industrial instrumentation.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*,  
4503 Wayne Ave., Philadelphia 44, Pa.



• Description and prices of a number of Brown instruments for metal processing are contained in Catalog No. 51-1 . . . send for your copy today.



#### VALVES

MOTORIZED VALVE ASSEMBLIES

PYROMETER ACCESSORIES

PANELBOARDS

SWITCHES, STARTERS, CONTACTORS, RELAYS

• Signalling • Transmitting

MINNEAPOLIS  
**Honeywell**

*Brown Instruments*

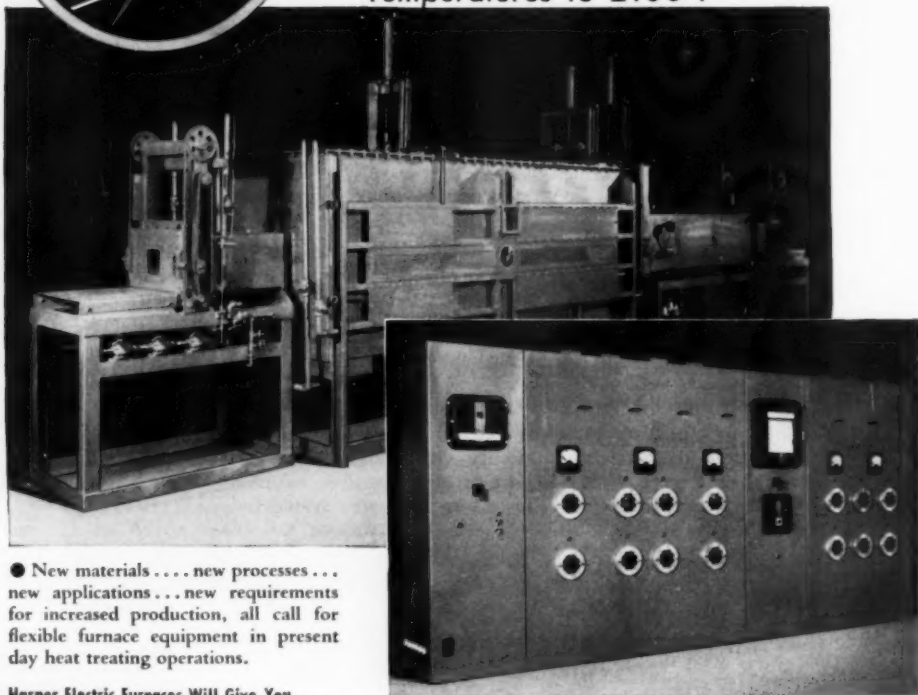




# ELECTRIC FURNACES

*For:* **SINTERING  
BRAZING  
GENERAL HEAT TREATING**

*Temperatures to 2100°F*



● New materials . . . new processes . . . new applications . . . new requirements for increased production, all call for flexible furnace equipment in present day heat treating operations.

**Harper Electric Furnaces Will Give You Maximum Flexibility of Use and Control in Your Heat Treating Operations.**

Shown above is a typical example of a Harper Electric Furnace with complete control panel, built to meet the requirements of a leading manufacturer in the Automotive Industry. The furnace provides for batch or continuous sintering, brazing, annealing, and general heat treating operations, and can be used with or without special atmospheres. This particular fur-

nace is constructed for manual operation with air operated doors so that heat treating procedures can be changed to meet day to day requirements. Mechanical pushing mechanisms make operation completely automatic.

Harper Electric Furnaces are available in many sizes and types to meet the diversified requirements of the heat treating industry. Write, telling of your needs, stating type, size, weight of product

and production requirements, heating cycle, available electric services and special characteristics, and Harper Engineers will be glad to recommend and quote on suitable equipment for you.

**HARPER ELECTRIC FURNACE  
CORPORATION**

Dept. 7, 39 River Street

Buffalo 2, New York



A TEN-FOLD

*Increase*

1951  
H. P.

IN  
TEN YEARS

SEE SPENCER AT  
BOOTH NO. G-260

1941  
H. P.

The horsepower of Spencer Turbo-Compressors installed annually has increased tenfold in as many years. The simplicity of design and dependability of the all-metal Spencer with wide clearances and ball bearings is responsible for impressive repeat orders. More than 30 furnace and oven manufacturers prefer Spencer for their equipment. And a widening of the applications for blowing, cleaning, cooling and drying with high volume, low pressure air has accounted for many new installations.

Are you familiar with the many ways air is being used in industry? The how, when, and where of compressed air is described in the new Spencer Data Books No. 107-C and 126-A. Ask for your copies now.

440-A

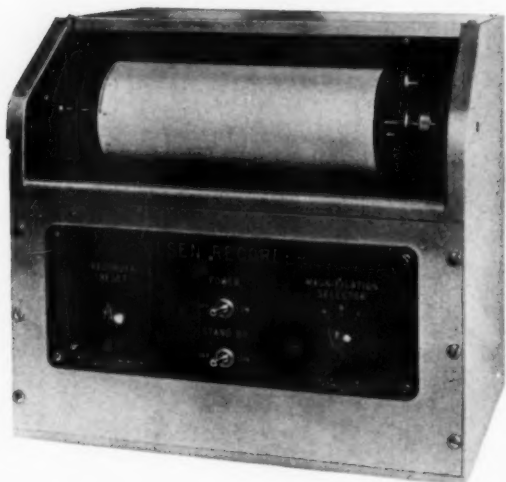
SPENCER  
HARTFORD  
TURBO-COMPRESSORS

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONNECTICUT

SPENCER  
HARTFORD

# THE All New OLSEN MODEL 51 ELECTRONIC RECORDER

(with **alcoltran**)



*For Stress-Strain Work in Tension, Compression, Flexure, and special applications*

- ★ Unexcelled Accuracy\*
- ★ A Self-Contained Unit
- ★ Simplified Controls and Instrumentation
- ★ No Gear changes—change magnification by flipping a switch
- ★ Response—full chart 4 seconds
- ★ Letter sized Curves
- ★ Simplified Chart Clip



Standard S-Type Extensometer



Standard Strain Instrument Type C-1  
Deflectometer and Crosshead.

- ★ Standard Instruments Available for Magnifications from 1000:1 to 1:1
- ★ Motion Detectors (differential transformers) available for special applications with linear motions from 0 to  $\pm 1.50''$  or 0 to  $\pm 2.50''$  (total travel 0.3'' to 5.0'')

\*All Olsen Recorders, Instruments, and Motion Detectors are calibrated to linear standards.

*Olsen At The Metal Show Booth D-216*

**TINIUS  OLSEN**

**Testing & Balancing Machines**

**TINIUS OLSEN  
TESTING MACHINE CO.**

2030 Easton Rd., Willow Grove, Pa.

Again the time has come  
to ask your company,  
and every company, to

# Get in the SCRAP

FOR every ton of ingot steel produced, at least a half-ton of iron and steel scrap must have previously reached the furnaces. Steel is currently being produced at full capacity, more than 100 million ingot tons annually—and there is a developing scrap shortage of serious proportions. Just as in the early years of World War II, the steel industry asks the help of all industry to relieve the situation.

## TWO IMPORTANT THINGS TO DO

**1 CLEAN OUT YOUR PLANT SCRAP.**  
This is a job that every company can do. Old, worn-out or out-moded and replaced machinery and equipment, rails, structural parts,

etc. constitute the "heavy melting scrap" which the steel industry needs most. Clean up *your* plant and yards—move out this heavy scrap into the channels of use.

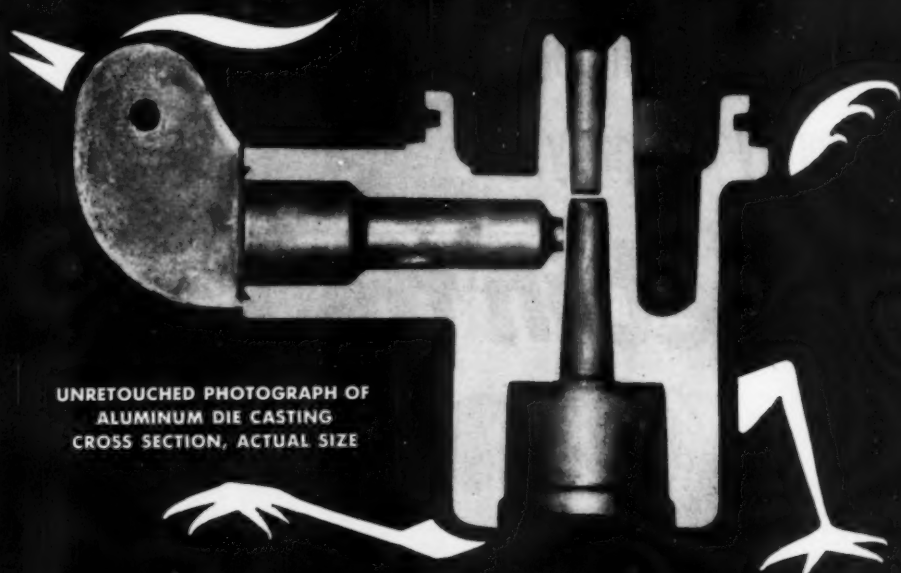
**2 HURRY BACK YOUR WORKING SCRAP.**  
Don't let the waste of metal-working—turnings, borings, punchings, crop ends, etc.—lie around the plant a day longer than necessary. Keep it moving, back to the furnaces. And doubly important, *be sure to classify and segregate your alloy steel scrap.* Thus handled, it not only commands a higher price, but will help to conserve the nation's supply of critical alloys, practically all of which are highly essential.

*Contributed in the National Interest by*  
**ALLEGHENY LUDLUM STEEL CORPORATION**

Henry W. Oliver Building • Pittsburgh 22, Penna.

W & O CL 3817

# Super Density is a Rare Bird



UNRETOUCHED PHOTOGRAPH OF  
ALUMINUM DIE CASTING  
CROSS SECTION, ACTUAL SIZE

... common to a **LESTER**

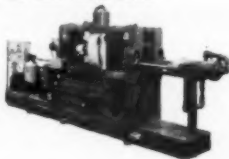


Here again is an example of how expert die casting technique, intelligent die design and a Lester machine make super-dense aluminum die casting possible. The part is an element of a hydraulic bumper jack, cast by Morton Manufacturing Company, in Omaha, Nebraska, on an early model HP-1-C.

As you can see, the wall thickness ranges from about  $3/32''$  to over  $3/8''$ . Besides, the part was required to withstand 4000 pounds of test pressure—and there have been less than 2% rejects! Skillful die design and gating, and proper cooling of die and core allow the job to be run at the rate of 120 shots per hour.

Interested in what a Lester-Phoenix Die Casting Machine can do for you? Write Lester-Phoenix or the representative in your area listed below.

Write for your free copy of the Lester Press.



## LESTER-PHOENIX DIE CASTING MACHINES

### REPRESENTATIVES

New York . . . . . Steven F. Krould  
Detroit . . . . . Thoreson-McCosh  
Chicago . . . . . J. J. Schmidt  
Cleveland . . . . . Don Williams  
Cincinnati . . . . . Index Machinery Corp.

Los Angeles . . . Seaboard Machinery Co.  
New England . . . Kavanagh Sales, Inc.  
San Francisco . . . J. Fraser Roe  
St. Louis, Milwaukee . . . A. B. Geers

### FOREIGN

Toronto, Canada . . Modern Tool Works, Ltd.  
London, England . . . Dowding & Doll, Ltd.  
Calcutta, India . . . Francis Klein & Co., Ltd.  
Sydney, Australia . . . Scott & Halladay, Ltd.  
Japan, New York . . . W. M. Howitt, Inc.

distributed by LESTER-PHOENIX, INC., 2619 CHURCH AVENUE • CLEVELAND 13, OHIO



take a **CLOSER LOOK** at



for:

- 1 Mechanical and pressure tubing.
- 2 Seamless and welded tubing.
- 3 Hot-finished, cold drawn or cold rolled, and rocked tubing.
- 4 Wide choice of grades: Stainless steels—B&W Croloys 12 to 27; Intermediate chrome molybdenum alloys—B&W Croloys  $\frac{1}{2}$  to 9; SAE-AISI alloys and nitralloy steels; Nickel steels—B&W Nicloys  $\frac{3}{16}$ , 5, and 9; Carbon molybdenum steels.
- 5 Sizes up to  $9\frac{5}{8}$ " OD in full range of wall thicknesses.
- 6 Wide choice of surface finishes—as rolled, as drawn, turned, scale-free, and polished.
- 7 Unannealed, annealed, tempered, and normalized conditions, or otherwise heat-treated as required.
- 8 Round, square, rectangular and other shapes; special ends and lengths.

**THE BABCOCK & WILCOX TUBE COMPANY**

Executive Offices: Beaver Falls, Pa.  
General Offices & Plants

Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing  
Alliance, Ohio—Welded Carbon Steel Tubing

Sales Offices: Beaver Falls, Pa. • Boston 16, Mass. • Chicago 3, Ill.  
Cleveland 14, Ohio • Denver, Colo. • Detroit 26, Mich.  
Houston 2, Texas • Los Angeles 15, Calif. • New York 16, N. Y.  
Philadelphia 2, Pa. • St. Louis 1, Mo. • San Francisco 3, Calif.  
Syracuse 2, N. Y. • Toronto, Ontario • Tulsa 3, Okla.



TA-1637Q

OCTOBER 1951; PAGE 239

**Perfect**  
**PRESERVATION**  
**Improved**  
**PACKAGING**  
**with** *Seal-Peel* **COATINGS**

**Save Time • Save Money • Save Shipping Weight • SAVE SPACE!**

- **Eliminate Wrapping!**
- **Application Simple!—Dip "In and Out"!**
- **Losses Cut! No Unhappy Customers!**

**Perfect Protection! Positive Identification!**

- **Eliminates Virtually All Risks!**
- **Easy and Safe to Work With!**
- **Less Overhead Expense!**

Get the facts on these space-saving, money-saving coatings at the Seal-Peel Booth A320, National Metal Exposition — or write for the 48-page Seal-Peel Guide to Better Preservation and Packaging.



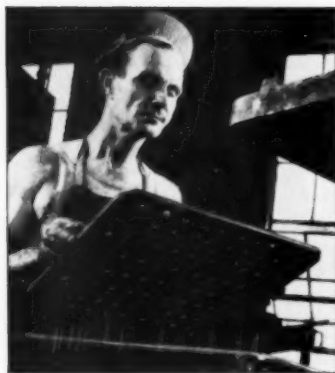
*Seal-Peel, Inc.*

**11400 East 9 Mile Road**

**Van Dyke (Detroit), Michigan**



## "EDCO BOTTOM BOARDS eliminate swelled castings"



Above photo shows Mid-City Foundry Company molder placing EDCO DOWMETAL Bottom Board on flask preparatory to pressing. Mid-City Foundry produces high quality gray iron and alloy castings.

Take a tip from E. F. Dublinski. He speaks from experience in saying —"EDCO DOWMETAL Bottom Boards eliminate swelled castings". Since switching to magnesium boards, Mid-City Foundry does not have castings ruined through swelling caused by depressions burned into out-dated wood boards.

EDCO DOWMETAL Bottom Boards help produce castings that are true to pattern. The exclusive grooved and vented design permits escape of gasses, and insures mold stability. Causes for rejects are kept to a minimum.

"We consider EDCO DOWMETAL Bottom Boards as permanent equipment at Mid-City," adds E. F. Dublinski, "because they'll outlast wooden boards at least 30 to 1 and in no time at all pay for themselves."

Your molders will like handling these boards because they are light in weight, easy to stack, and there's no danger of splinters. EDCO DOWMETAL Bottom Boards will not warp or rot—there are no nails to come out, nothing to break or split—no upkeep.

*Write us, or phone CApol 7-2060 for price schedule and list of 74 standard sizes available from stock.*



**CHRISTIENSEN CORPORATION**  
1519 N. KILPATRICK AVENUE • CHICAGO 51, ILLINOIS

Aluminum Alloy Ingots • Zinc Base Casting Alloys



# Kanthalize

**your product for superior performance**

Now, with the opening of our new plant at Stamford, Connecticut, you can kanthalize your electric appliances and furnaces with complete confidence.

Here, we are producing the world-recognized Kanthal line of High-Temperature Electric Resistance Materials . . . Resistance Wire, Ribbon, and Strip for applications up to 2460° F (1350° C) . . . on an accelerating schedule of deliveries.

Here, you will always find the same painstaking technical service and the same high engineering standards which have characterized the manufacture of Kanthal in Sweden for over 20 years.

#### There Is No Substitute For Kanthal

Kanthal is an Iron-Chromium-Aluminum-Cobalt Alloy . . . a notable material which withstands most economically the highest temperatures among the non-precious resistance alloys. There is NO substitute for Kanthal, no matter what may be claimed for competitive materials.

#### Kanthal Materials Come in Four Types

	MAX. OPERATING TEMP.	OHMS PER CMF	FORMS	APPLICATIONS
KANTHAL A-1	2460° F	872	Wire & Strip	Ceramic Kilns, High-Temperature Heat-Treating and Laboratory Furnaces, etc.
KANTHAL A	2370° F	837	Wire & Ribbon	Pottery Kilns, Heat-Treating Furnaces, High-Resistivity Resistors, Industrial Heaters, etc.
KANTHAL D	2100° F	812	Wire, Ribbon, Strip	Appliances and Furnaces: toasters, irons, and enclosed units as in electric ranges. Outstanding resistance to oxidation.
KANTHAL DS ("D-Special")	2100° F	812	Wire, Ribbon, Strip	Similar to KANTHAL D, but for applications where maximum creep strength and ductility are required.

For full data on Kanthal for your product, write us on your company letterhead. We want you to have our unusually complete KANTHAL HAND BOOK, 1951 Edition.



**KANTHAL CORPORATION**

Amelia Place (parallel to New Haven R.R.)  
Stamford, Conn., Telephone Stamford 48-9251

See us at the Metal Show for data on how to kanthalize . . . Booth G-352



## ROTARY MOVES AHEAD

Rotary's expanded modern production facilities offer  
ELECTRIC FURNACE QUALITY STEELS.

Complete facilities for heats, billets and slabs—for  
cold finishing and annealing—are available in this  
new modern plant.

### ROTARY ELECTRIC STEEL CO.

501 70 • DETROIT 70, MICHIGAN



## How a Pittsburgh Brush Solved an Oil Pressure Problem\*



\* An actual case history from the Allis-Chalmers Pittsburgh Works, manufacturers of transformer.

At Allis-Chalmers, well-known manufacturer of industrial equipment, the problem was to secure a satisfactory oil pressure test on transformer radiators. The key to the problem was to find a brush narrow enough to clean between cooling fins and strong enough to remove slag and spall on welds which could conceal pinholes. Pittsburgh engineers recommended an 8" rotary wire brush. The brush proved more than satisfactory and the problem was solved!

### Let Pittsburgh Engineers Solve Your Brush Problems.

Pittsburgh's complete line of brushes of every type, for every purpose, will provide a practical and economical solution of any brush problem you might have. Drop us a line on your company letterhead for a copy of our new booklet that shows, through actual case histories, how Pittsburgh can help cut your brushing operation costs. Address: PITTSBURGH PLATE GLASS COMPANY, Brush Div., Dept. W7, 3221 Frederick Ave., Baltimore 29, Md.



## PITTSBURGH

**Power Driven BRUSHES**  
BRUSHES • PAINT • GLASS • CHEMICALS • PLASTICS  
**PITTSBURGH PLATE GLASS COMPANY**

## COLD LIGHT BALANCE LAMP designed for analytical balances



The Eberbach Balance Lamp gives complete illumination, speeds weighings, reduces errors, prevents eyestrain. It has excellent ventilation to dissipate any possible heat build-up. Rubber feet raise the lamp, and louvers on top permit complete circulation. Stream-lined in appearance. Finish, black wrinkle; overall measurements, 18½" long by 4½" wide by only 1½" high. For 115 volt, 60 cycle AC. Price is \$17.50.

*Eberbach*  
AN ARBOR, TRICH.

SCIENTIFIC  
INSTRUMENTS  
& APPARATUS  
CORPORATION  
ESTABLISHED 1922

## BALL BEARINGS MANUFACTURERS USE AGF FURNACES



These AGF Model No. 2GA Rotary Gas Carburizers are preferred by most of the largest ball bearing manufacturers. The illustrations are of actual installations where amazing production has been constant over a period of many years.

Write for Bulletin No. 1271A



**AMERICAN GAS FURNACE CO.**  
1002 LAFAYETTE STREET, ELIZABETH 4, N. J.

# keep up with the whirl(d) . . .

of events that have been developed in foundry technique for Heat and Corrosion Resistant Castings. The ALLOY ENGINEERING and CASTING COMPANY extends a cordial invitation to ASM Members, Affiliate Members and Conferees of the World Metallurgical Congress to visit their exhibit at the National Metal Show in Detroit the week of October 15-19, 1951. Get the facts direct from these engineers why ACCOLOY castings can show a profit in your production schedule. See for yourself the versatile engineering skill that is characteristic of these castings.



On hand to greet you in Booth No. B-107 will be Art LaMasters, Bill Davis, George Rogers, Frank Staral, Frank Faery, Bert Sutherland, Walter Edens, and Tom McNamara, who will show you *why* ACCOLOY castings are "preferred by industry"!

## ALLOY ENGINEERING & CASTING COMPANY

ALLOY CASTING CO. (Div.)

CHAMPAIGN • ILLINOIS

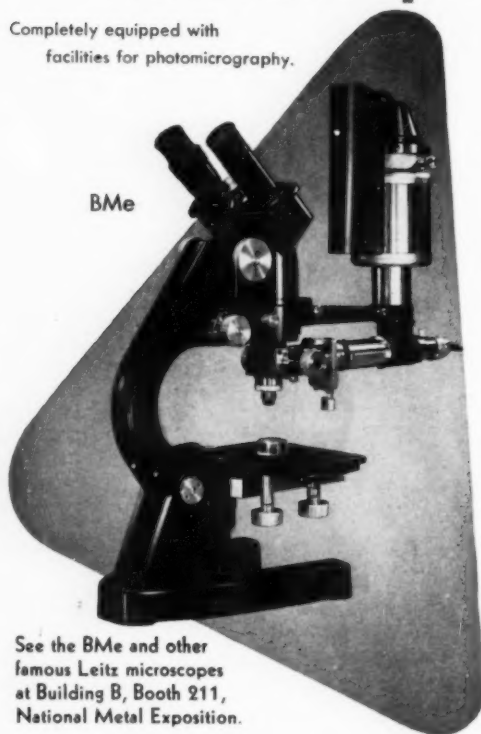
ENGINEERING IS PHILOSOPHY...GOOD ENGINEERING, PURE LOGIC

OCTOBER 1951; PAGE 245

# The new *Leitz* Metallurgical Microscope

Completely equipped with  
facilities for photomicrography.

BMe



See the BMe and other  
famous Leitz microscopes  
at Building B, Booth 211,  
National Metal Exposition.

For information, see your Leitz  
franchised dealer, or write to Dept. MP 106

**E. LEITZ, Inc.,** 304 Hudson Street, New York 13, N. Y.

LEITZ MICROSCOPES • SCIENTIFIC INSTRUMENTS  
BINOCULARS • LEICA CAMERAS AND ACCESSORIES

METAL PROGRESS; PAGE 246

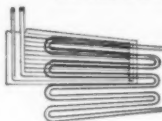
**you save 50%**  
in TANK HEATING and COOLING with

**PLATECOIL**

(REPLACE PIPE COILS)



**You SAVE 50% in tank SPACE**



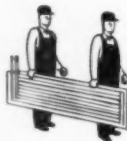
A 22" x 47" Platecoil gives the same heat transfer surface as 32 ft. of 1½" pipe. This pipe requires a space approximately 30" x 60". Platecoil thus saves about 50% over equivalent pipe coil in space inside your tank.

**You SAVE up to 50% in initial COST**



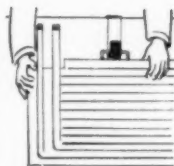
The initial cost of Platecoil is often 50% or more below the cost of equivalent pipe coil depending, of course, on the materials used in construction. Less time is required to install Platecoil with corresponding saving in installation labor.

**You have 50%  
LESS WEIGHT to handle**



Weighing only about half as much as equivalent pipe coil, Platecoil is easy to handle. A whole maintenance crew is not needed to transport and install it.

**You SAVE 50%  
in maintenance LABOR**



The Platecoils can be replaced in a matter of minutes and without emptying the tank. There is no need for workmen to get inside the tank in order to make replacements.

**See Us at Booth G-345**

**PLATECOIL**  
DIVISION

KOLD HOLD MFG. CO.  
LANSING 4, MICHIGAN

## KING PORTABLE BRINELL

### HARDNESS TESTER

Eliminates excessive material handling costs in routine and special Brinell hardness testing. The King Portable Brinell can be carried to the work, used in any position, and always puts an actual load of 3000 kg. on the 10-mm. ball indenter.

This 27-lb. portable tester has a 4-in. deep throat and a gap 10 in. high. For larger pieces, the test head is easily removable for testing sections beyond the capacity of the standard base.

Simple to operate, the tester is impossible to overload, and even with inexperienced operators will provide consistent accurate results well within the requirements of the Bureau of Standards.



**ANDREW  
KING**  
NARBERTH, PENNA.

SEE AT BOOTH B-122



Throat—4" deep. Gap—10" high.  
Weight—26 lbs.

## VOLUME PRODUCTION

for

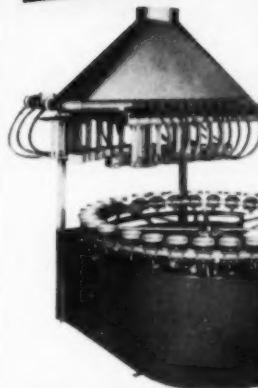
- Soldering
- Brazing
- Annealing
- Hardening

with  
**G. A. S.**  
HIGH SPEED  
"LOCALIZED HEATING"  
UNITS

G.A.S. High Speed Heating Units permit highest production rates possible. A revolutionary design in burners provides high temperature localized heating. Production rate—3000 pieces per hr. Furnished with or without holding fixtures making it possible to handle large variety of parts. G.A.S. Turntable and Conveyor-Type Heating machines make production heating profitable.

SEE US  
AT THE  
METAL SHOW

One of the G.A.S. Turntable Heating Machines with rotating fixtures and high speed Zig-Zag burners for brazing bomb and shell assemblies, annealing cartridge cases, etc.



**GAS APPLIANCE SERVICE, INC.**

*Industrial Gas Engineers*

1201 WEBSTER AVENUE • CHICAGO 14, ILLINOIS



## Heroult ELECTRIC MELTING FURNACE

... as ever, the dependable furnace for the production of high-grade stainless, alloy and rimming steels.

Removable roof of new design now available for the larger furnaces.

**AMERICAN BRIDGE COMPANY**  
General Offices: Frick Building, Pittsburgh, Pa.

Contracting Offices in New York, Philadelphia, Chicago,  
San Francisco and other principal cities  
United States Steel Export Company, New York

USS

**AMERICAN BRIDGE**

UNITED STATES STEEL

# Engineered

for **34** CONSECUTIVE **Years!**

**GENERAL ALLOYS HAS BEEN THE LARGEST  
AND ONLY CONTINUOUS ALLOY CASTING EXHIBITOR  
AT THE NATIONAL METAL SHOWS**

**"Out in Front at the Main Entrance"**

It has been our *privilege* to attend the Birth, and to "Grow up" with A.S.M., an abundantly stimulating and satisfying EXPERIENCE. Embracing three wars—the development of the Automobile, Aircraft, and Process Industries—our GEOMETRICAL U. S. METALS PROGRESS is the guts and sinews of PRODUCTION and Industrial Expansion which insures the STRENGTH to keep us FREE. Alloys play a vital role. Of such alloys, we produce the highest and most complex in volume production.

As the FIRST Company organized for, and exclusively devoted to the production of Heat & Corrosion Resistant Alloys, G.A. began with ENGINEERING and METALLURGICAL research and development of high temperature & chemical process "tooling". Encountering limitations in process, we pioneered in the development of casting TECHNOLOGY and fabricating techniques, repeatedly crossing new horizons in CO-ORDINATING design, metallurgy, and process & structure to improve the *functional & economic* SERVICE of ENGINEERED alloy tooling for industry.

Men of A.S.M. bring their sons to the G.A. Booth at the Metal Shows, who were, themselves, brought there by *their* fathers. We receive no higher compliment. These three generations have seen a far greater variety, and a larger number of ENGINEERED alloy castings exhibited by G.A. at A.S.M. Shows than by all contemporaries combined. They know that G.A. pioneered in the development of the majority of modern FURNACE MECHANISMS, for the majority of leading Furnace Builders. They know that G.A. is not a "Foundry", but a National Engineering Organization whose products are generally higher in "First-Cost", but far more *economical to use*.

We naturally attract those who share our Philosophy that "That which is truly Functional is truly Beautiful"—leaders, too, in their respective fields, who make, and who demand, first quality products. In this young, vital, and increasingly specialized field of Complex Alloys, the old maxim, "There is no Substitute for Experience", is most aptly applied.

*Robert Harris*

**QALLOYS**

THE QUALITY NAMES IN ALLOY  
FOR HEAT CORROSION ABRASION

**X-ite**



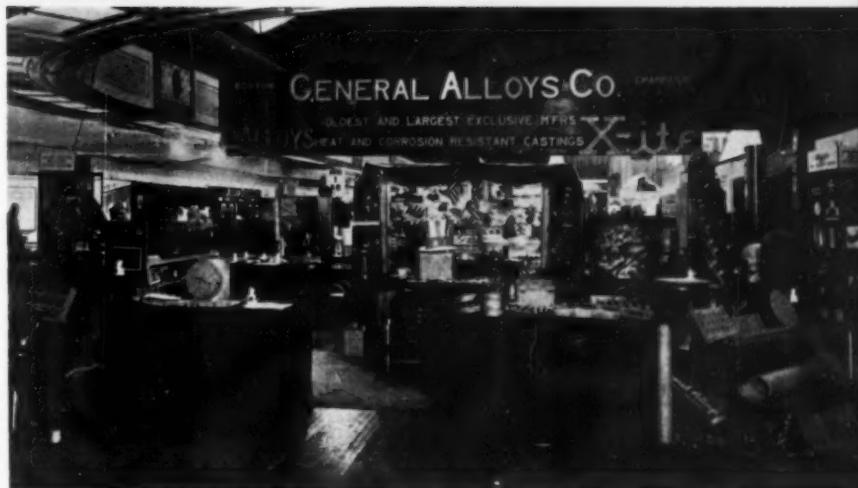
# Alloys — GA

## Seeing is Believing!

The continuing **ADVANCE** in **G.A. DESIGNS** for increasing **Defense Production**, as well as the **Casting Quality**, reflecting continuing and accelerated **Research & Development in Process Control**, is best **SEEN**, to be fully appreciated.

**G.A. invites COMPARISON.** If you have a tough alloy problem on any **Defense Production** project, "Classified", or otherwise, **Qualified Engineers** will consult without obligation.

**Our Allies** from **Overseas**, as well as all **Government Personnel**, are invited to review new developments in **Casting Process**, resulting from our work on extensive **R. & D. Projects** for the **Armed Services**, and as yet restricted to specialized applications.



## ALLOY PROGRESS

**R**esearch & Development, with **G.A.**, is not a side-issue, but a major activity of the Company. Our President and major Engineering Executives have devoted a large portion of their time, for many years, to the most comprehensive and broadly implemented **Casting Process** Developments for the **Armed Services**, leading Industries, and independently.

**N**ew Processes, originally planned for release to Indus-

try, are, since **Korea**, and currently, "**RESTRICTED**" to specialized **Defense Projects**. Each such Project is an **increment of PROGRESS**, toward vastly improved physical and dimensional specifications in castings. Such improvements are not restricted to **Alloys**, but are broadly applicable to castings in most metals. They will accelerate much—long overdue—**OBSOLESCENCE**, and open new fields for castings in Industry.

## GENERAL ALLOYS COMPANY, BOSTON, MASS.

"OLDEST AND LARGEST EXCLUSIVE MFRS. OF HEAT & CORROSION RESISTANT CASTINGS"

### BRANCH OFFICES AND REPRESENTATIVES

**BALTIMORE**  
Gethmann Ind. Corp.  
513 Park Ave.

**BIRMINGHAM**  
Harry G. Mount  
544 American Life Bldg.

**BOSTON**  
General Alloys Co.  
405 West First St.

**BUFFALO**  
R. E. Lynd  
812 Tacoma Ave.

**CHICAGO**  
General Alloys Co.  
224 S. Michigan Ave.

**CLEVELAND**  
E. E. Whitinside  
1211 St. Clair Ave.

**PITTSBURGH**  
H. P. Schneider  
1432 Potomac Bldg.

**DENVER**  
Tracy Jarrett  
3501 Valjejo St.

**DETROIT**  
General Alloys Co.  
3-147 Gen'l Motors Bldg.

**FORT WAYNE**  
Geo. O. Desautels Co.  
410 Utility Bldg.

**HOUSTON**  
William E. Brice Co.  
1512 Pease Ave.

**INDIANAPOLIS**  
Geo. O. Desautels Co.  
2302 N. Meridian St.

**MILWAUKEE**  
Walt Gerlinger, Inc.  
610 West Michigan St.

**ST. LOUIS**  
Associated Steel Mills, Inc.  
1831 So. Kingshighway

**MUNCIE**  
Geo. O. Desautels Co.  
Wysor Bldg., P.O. Box 770

**NEW YORK**  
General Alloys Co.  
60 Church St.

**PHILADELPHIA**  
John P. Clark Co.  
1428 South Penn Square

THE FOOTSTEPS OF GENERAL ALLOYS MARK THE PATH OF AN INDUSTRY

# We need 3000 Carloads of Scrap a Day

Every pound of dormant scrap you can furnish will help to keep the steel mills and foundries producing



Steel mill furnaces are gobbling up scrap faster than it's being delivered. To maintain planned schedules of steel production for both military and civilian purposes, the mills must have more iron and steel scrap.

## Get in the Scrap—Yourself!

Whatever your business, you undoubtedly have scrap. If there's dust on it or rust on it—it may be scrap. If it's scrap—it's needed.

Turn it over to your local scrap dealer and help lick this critical scrap shortage.

## What you can do to help

1. Appoint one top official in your plant to take full responsibility for surveying the plant and getting out the scrap.
2. Consult with your local Scrap Mobilization Committee about its program to help out in the scrap crisis. The nearest office of the National Production Authority, Department of Commerce, can tell you who your local Scrap Mobilization chairman is.
3. Call in your local scrap dealer to help you work out a practical scrapping program. Non-ferrous scrap needed, too!
4. Write for free booklet, "Top Management: Your Program for Emergency Scrap Recovery", addressing Advertising Council, 25 W. 45th St., N. Y. 19.

SCRAPPY SAYS:

**AID DEFENSE  
MORE SCRAP  
TODAY...  
MORE STEEL  
TOMORROW**



## FACTS YOU SHOULD KNOW ABOUT STEEL PRODUCTION

Steel production.....	1950.....	97,800,000 net tons
Estimated capacity.....	1952.....	119,500,000 net tons
Purchased scrap used*.....	1950.....	29,500,000 gross tons
Estimated purchased scrap requirement*.....	1952.....	36,200,000 gross tons

\*All consumers

*This advertisement is a contribution, in the national interest, by*

# METAL PROGRESS

# METALLURGISTS

## SYLVANIA'S

Research Laboratories  
on Long Island

need a number of metallurgists to work on development of production processes in the field of powder metallurgy. B.S. or better in metallurgy essential. Several years experience in metallurgical development & processing, preferably in the powder metallurgy field, desirable. Will also consider graduate metallurgists with little or no experience & strong interests in this field.

These positions offer unusual opportunities to contribute to SYLVANIA'S steady expansion in this field. Modern, fully equipped laboratories under construction in Bayside, Long Island, to accommodate our expansion.

Please send complete resume, including education, experience, citizenship status & salary requirements, to:

Manager of Personnel

## SYLVANIA

Electric Products, Inc.

Dept. P-1

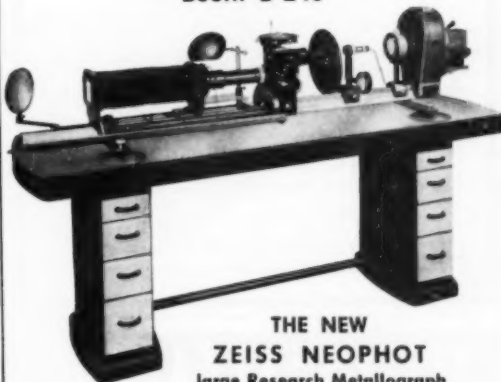
40-22 Lawrence St.

Flushing, N. Y.

You are invited  
to inspect the latest developments  
in

## CARL ZEISS INSTRUMENTS

at the National Metal Exposition  
October 15th to 19th  
Booth B-243



THE NEW  
ZEISS NEOPHOT  
Large Research Metallograph

See it at  
the show



Shop and Toolmakers'  
Microscopes  
Universal Measuring  
Microscopes  
Optimeters and Ultra-  
Optimeters  
Optical Protractors  
Optical Dividing Heads  
Abbe Vertical and Uni-  
versal Microscopes  
Finish Testers  
Optical Parallels and Flats  
Indicating Micrometers  
Dial Gauges  
Orthotests  
and other precision  
measuring instruments for  
the Metal industry.

We invite  
your  
inquiries

Scientific Instrument Division

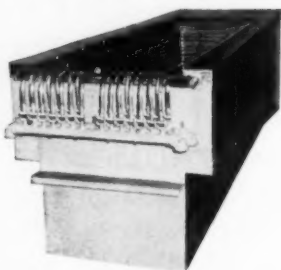
## ERCONA CORPORATION

527 Fifth Avenue, New York 17, N. Y.

Exclusive American Agency for Carl Zeiss, Jena Instruments

To Eliminate Costly Down Time

..... SPECIFY HEIL LINED PROCESS TANKS



Lead Lined Sulphuric Acid Anodizing Tank

• **LONGER LIFE** assured in your lined process equipment by our complete fabrication facilities and years of experience in selecting and applying the best lining for your specific requirement.

- **PLATING TANKS**
- **PICKLING TANKS**
- **CHEMICAL PROCESS**
- **RUBBER**
- **KOROSEAL**
- **LEAD**

Send for Illustrated Literature

**HEIL** Process Equipment Corporation  
12901 Elmwood Ave., Cleveland 11, O.

Use

**ALOX**

**RUST  
INHIBITORS**



Insist on the use of ALOX 311-940-707 inhibitors for the maximum protection of steel parts during fabrication, assembly, storage and shipment.

Successfully used to protect overseas shipment of war equipment during World War II. Today these film forming rust preventives containing ALOX inhibitors are used in the control of corrosion of farm and construction equipment.



Write for literature on ALOX products and where to buy the rust preventives containing ALOX

See our Exhibit—Booth 112—Building C

**ALOX CORPORATION**  
3929 Buffalo Avenue  
Niagara Falls, New York

**PYRASTEEL**

*Alloy* **PARTS**

for maximum resistance to

**2000°  
F. Heat**

**Gases**

**Acids**

Write for  
**PYRASTEEL**  
Bulletin



PYRASTEEL Castings are the "main defense line" against destructive agents that impair ordinary steel parts.

PYRASTEEL is a modern-type, electric-furnace, chrome-nickel-silicon alloy that withstands oxidation and corrosion up to 2000° F., and also resists gases and most concentrated or dilute commercial acids.

Because of its proved durability under severe conditions, PYRASTEEL insures record serviceability and economy in such diverse applications as furnace parts, food processing equipment, chemical manufacturing, heat treating operations, and oil refinery work.

There is a suitable grade of PYRASTEEL for practically every purpose in heat-resistant applications.



**CHICAGO STEEL  
FOUNDRY CO.**

Kedzie Ave. & 37th St., Chicago 32, Ill.

• **Makers of Alloy Steel for Over 40 Years**

MICHIGAN STATE FAIR GROUNDS

DETROIT

# 3 *Metal Yardstick-* MILESTONES LONG...

Milestones of metal progress . . . of metal research . . . of world-wide metal conservation and utilization . . . these are the brilliant features of the National Metal Exposition of '51 . . . features that will lend a strong lure to the nation's newest and finest achievements in the metal industry. Ask yourself where else on earth you could find concentrated in one place the best brains and the best products of a free world's finest and most basic industry. Be there!

**Detroit, Mich.— Oct. 15-19**

**NATIONAL METAL  
EXPOSITION**

**NATIONAL METAL  
CONGRESS**

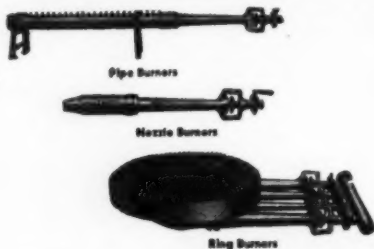
**WORLD  
METALLURGICAL  
CONGRESS**



## BUZZER Gas BURNERS

*For Many Industrial Gas Uses*

**NO BLOWER or POWER NECESSARY**  
... just connect to gas supply



Designed to solve numerous Industrial Gas applications, "BUZZER" Burners are unexcelled for Efficiency, Economy, Simplicity and Flexibility. Large variety of models available.

Send for the "BUZZER" Catalog showing complete line of Industrial Gas Burners, Furnaces and other equipment.

**CHARLES A. HONES, INC.**

123 So. Grand Ave.

Baldwin, L. I., N. Y.

## BORON STEEL

### Table of Contents

- Boron Steels, by Panel on Conservation, Metallurgical Advisory Board
- A.I.S.I. List of Tentative Standard Boron and Alternate Steels
- Historical Development of Boron Additions, *by Robert S. Archer*
- Summary of Wartime Investigations of Boron in Steel, *by Murray C. Udy*
- Use of Boron Steel in Production of Hand Tools, *by Fred J. Robbins and J. J. Lawless*
- Caterpillar Tractor Co.'s Experience with Boron Steels, *by John Parina, Jr.*
- Special Carburizing Steels, Boron Treated, *by Porter R. Wray*

Plus a Supplement on Hardenability Test and Use

\$1.00 per copy

**American Society for Metals**  
7301 Euclid Ave., Cleveland 3, Ohio

**"Temperature**

**within  $\pm 3^\circ$  Fahrenheit!"**



These radial brackets for Marshall Furnaces can be furnished in stationary or compensating types.

Marshall tubular Furnaces and Control panels aid you to get accurate data in every tensile, fatigue, creep and rupture test of metals at high temperature. In this service, Marshall furnaces make it easy to maintain a temperature uniformity of (plus or minus)  $3^\circ$  Fahrenheit over the gauge length of the specimen. Many users even report a temperature uniformity of  $1^\circ$  throughout the test. Write for literature. Marshall Products Co., 270 W. Lane Ave., Columbus, Ohio.

**MARSHALL**  
HIGH TEMPERATURE FURNACES

CONTROL PANELS

# Metal Progress

Taylor Lyman, *Publisher*

A. P. Ford, *Sales Manager*

George H. Loughner, *Production Manager*  
7301 Euclid Ave., Cleveland 3—Utah 1-0200

## District Managers

Harry L. Gebauer and John F. Tyrrell

55 W. 42nd St., New York 18—CHickering 4-2713

Ralph H. Cronwell

482 Burton Ave., Highland Park, Ill.—Highland Park 2-4263

Donald J. Billings

7301 Euclid Ave., Cleveland 3—Utah 1-0200

PUBLISHED BY AMERICAN SOCIETY FOR METALS, 7301 EUCLID AVE., CLEVELAND 3, OHIO—W. H. EISENMAN, SECRETARY

## • Index to Advertisers •

Acheson Colloids Corp. .... Back Cover	Chase Brass & Copper Co. .... 51	Heil Process Equipment Corp. .... 255
Acme Manufacturing Co. .... 42	Chicago Steel Foundry Co. .... 252	Hevi Duty Electric Co. .... 172
Adams Carbide Corp. .... 210	Christiansen Corp. .... 241	Hill Arme Co. .... 150
Air Reduction Sales Co. .... 6-5	Cincinnati Milling Machine Co. .... 199	Hines, Inc., Charles A. .... 254
Ajax Electric Co. .... 147	Cities Service Oil Co. .... 153	Hoshins Manufacturing Co. .... 127
Ajax Electrothermic Corp. .... 45	Clark Instrument, Inc. .... 220	Houghton & Co., E. F. .... 6-7
Ajax Manufacturing Co. .... 64	Cleveland Crane & Engineering Co. .... 141	
Aldridge Industrial Oils, Inc. .... 136	Cleveland Electric Laboratories Co. .... 136	
Alloy Research Products, Inc. .... 118, 126	Climax Molybdenum Co. .... 212	Illinois Testing Laboratories .... 214
Alloy Engineering and Casting Co. .... 245	Columbia Tool Steel Co. .... 120	Imperial Plating Rack Co. .... 133
Alloy Precision Casting Co. .... 131	Commercial Steel Treating Corp. .... 137	Induction Heating Corp. .... 107
Alloy Rods Co. .... 128B	Continental Industrial Engineers, Inc. .... 148	Industrial Heating Equipment Co. .... 134, 231
Alox Corporation .... 232	Cooper Alloy Foundry Co. .... 197	Ingersoll Steel Div., Borg-Warner Corp. .... 151
Aluminum Co. of America, 176A, B, C, D, E, F	Cowles Chemical Co. .... 183	Inland Steel Co. .... 18
Alvey-Ferguson Co. .... 266	Crucible Steel Co. of America .... 137	International Nickel Co., Inc. .... 11, 16A, 230
American Bridge Co. .... 247		Ipsen Industries, Inc. .... 15
American Chemical Paint Co. .... 202	Dahlbom Co., C. A. .... 142	
American Cyanamid Co. .... 200	Daniels Plating Barrel & Supply Co. .... 123	Jarrell-Ash Co. .... 182
American Enterprise Co. .... 141	Darwin & Milner, Inc. .... 141	Jenop Steel Co. .... 128A
American Gas Furnace Co. .... 244	Despatch Oven Co. .... 189	Johns-Manville .... 128
American Machine & Metals, Inc. .... 22	Detroit Corp. .... 132	
American Non-Gran Bronze Co. .... 121	Detroit Testing Machine Co. .... 140	Kanthal Corporation .... 242
American Optical Co. .... 178	Dice Co., J. W. .... 129	Kasent Co., Inc. .... 136
American Platinum Works .... 9	Distillation Products, Inc. .... 26	Kemp Manufacturing Co., C. M. .... 166
American Rack Co. .... 123	Dow Chemical Co. .... 168, 229	Kennametal, Inc. .... 201
American Roller Die Corp. .... 141	Dow Furnace Co. .... 198	Kent Cliff Laboratories .... 140
American Smelting & Refining Co. .... 149	Drever Co. .... 138, 193	King, Andrew .... 247
American Society for Metals .... 123, 130, 139, 233, 234	Driver-Harris Co. .... 165	Kloster Steel Corp. .... 119
Ames Precision Machine Works .... 27		Kold-Hold Manufacturing Co. .... 246
Ampeco Metal, Inc. .... 44-45	Eastman Kodak Co. .... 117	Kern, Inc., Wm. .... 143
Amplex Manufacturing Co. .... 207	Eberbach Corporation .... 244	
Applied Research Laboratories .... 146	Ecco High Frequency Corp. .... 196-197	Lakeside Steel Improvement Co. .... 138
Arcos Corp. .... 204-205	Ekolup Fuel Engineering Co. .... 171	Lalite Steel Co. .... 211
Armour & Co., Ammonia Division .... 158	Ekstrand & Tholand, Inc. .... 142	Latrabe Electric Steel Co. .... 2
Armstrong-Blum Mfg. Co. .... 104	Electric Furnace Co. .... Inside Back Cover	Lavin & Sons, Inc., E. .... 46
Ashworth Brothers, Inc. .... 155	Electric Alloys Co. .... 1	Leake Stamping Co. .... 143
Austenal Laboratories, Inc. .... 22	Electro Metallurgical Division, Union Carbide & Carbon Corp. .... 112-113	Leeds & Northrup Co. .... 3, 163
	Electric Products Laboratories .... 218	Leitz, Inc., E. .... 246
Babcock & Wilcox Tube Co. .... 230	Enthone, Inc. .... 181	Lepel High Frequency Labs. .... 217
Baird Associates, Inc. .... 184	Ercora Corporation .... 231	Lester-Phoenix, Inc. .... 238
Baker & Adamson Products, General Chemical Division, Allied Chemical & Dye Corp. .... 19	Erie Products, Inc. .... 143	Lindberg Engineering Co. .... 18A, B, C, D
Baker & Co., Inc. .... 132, 179	Erie Foundry Co. .... 148	Lindberg Steel Treating Co. .... 137
Baldwin-Lima-Hamilton .... 200		Linde Air Products Co., Unit of Union Carbide & Carbon Corp. .... 17
Barber-Colman Co. .... 140	Fahrerley Co. .... 215	Little Falls Alloys, Inc. .... 142
Barrett Division, Allied Chemical & Dye Corp. .... 196	Fink & Sons Co., A. .... 33	Livingstone Engineering Co. .... 132, 236
Bausch & Lomb Optical Co. .... 60D	Firth-Sterling Steel & Carbide Corp. .... 173	Loftis Engineering Corp. .... 187
Beryllium Corp. .... 219	Foxboro Co. .... 12-13	Lumite Div., Universal Atlas Cement Co. .... 136
Bethlehem Steel Co. .... 145		
Biddle Co., W. S. .... 128	Gas Appliance Service, Inc. .... 247	Magnetothermic Corp. .... 124
Boder Scientific Co. .... 31, 140	General Alloys Co. .... 248-249	Magnetic Analysis Corp. .... 139
Brandt, Inc., Charles T. .... 25A	Gordon Co., Claud H. .... 206, 220	Magnus Chemical Co. .... 216
Buehler, Ltd. .... 221	Great Lakes Steel Corp. .... 121	Manhattan Rubber Div., Kaybates-Manhattan, Inc. .... 121
Burrell Corp. .... 24	Grieve-Hendry Co., Inc. .... 135	Marley Co., Inc. .... 20
	Gulf Oil Corp. .... 169	Marshall Products Co. .... 254
Carburendum Co. .... 60, 63		Marquardt Electric Co. .... 208
Carl-Mayer Corp. .... 154	Handy & Harman .... 35	Maurath, Inc. .... 143
Carlson, Inc., G. O. .... 174	Harper Electric Furnace Corp. .... 234	Mechanite Metal Corp. .... 26
Carpenter Steel Co. .... 38	Harshaw Chemical Co. .... 52	Meriam Instrument Co. .... 129
Case Hardening Service Co. .... 135	Hayes, Inc., C. I. .... 203	Merrill Brothers .... 154
Chace Co., W. M. .... 186	Haynes Stellite Co., Union Carbide & Carbon Corp. .... 48B	Metallizing Co. of America .... 236
Char Products, Inc. .... 170	Hays Corp. .... 136	Michigan Steel Casting Co. .... 213

Milne & Co., A. ....	164
Minneapolis-Honeywell Regulator Co. (Industrial Div.) .....	154, 232-233
Mitchell-Bradford Chemical Co. ....	162
Morganite, Inc. ....	218
Morrison Engineering Co. ....	134
Mueller Brass Co. ....	175

National Carbon Division, Union Carbide & Carbon Corp. ....	177
National Machinery Co. ....	38-59
National Rack Co., Inc. ....	153
National Radiator Co. ....	180
National Spectrographic Laboratories, Inc. ....	139
Niagara Blower Co. ....	122
North American Manufacturing Co. ....	135
Northwest Chemical Co. ....	269
Norton Co. ....	64A, B, C, D
Nox-Rust Chemical Corp. ....	47

Ohio Steel Foundry Co. ....	155
Olsen Testing Machine Co., Tinius ....	236
Opplem Co. ....	228

Pangborn Corp. ....	124-125
Park Chemical Co. ....	49
Pearson Industrial Steel Treating Co. ....	137
Perry Equipment Co. ....	135
Peters-Dalton, Inc. ....	133, 226
Picker X-Ray Corp. ....	183
Pike and Co., E. W. ....	140
Pittsburgh Commercial Heat Treating Co. ....	138
Pittsburgh Plate Glass Co. ....	244
Pittsburgh Steel Co. ....	18

Pittsburgh Tool Steel Wire Co. ....	195
Pressed Steel Co. ....	16
Purdy Co., Inc., A. R. ....	142
Pyrometer Instrument Co. ....	153

Raybestos-Manhattan, Inc. ....	131
Reliable Steel Co. ....	141
Republic Steel Corp. ....	61
Revere Copper & Brass, Inc. ....	115
Reynolds Metals Co. ....	160A, B
Richards Co., Inc., Arklay S. ....	136
Rigidized Metals Corp. ....	142
Rockwell Co., W. S. ....	216
Rolock, Inc. ....	48, 132
Rotary Electric Steel Co. ....	243
Rubicon Co. ....	212
Ryerson & Son, Inc., Jos. T. ....	66

Sandvik Steel, Inc. ....	56
Sargent & Co., E. H. ....	158
Sciaky Brothers ....	223
Seal-Feel, Inc. ....	133, 249
Sentry Co. ....	116
Sherman Industrial Electronics Co. ....	134
Solventol Chemical Products, Inc. ....	133
Spencer Turbine Co. ....	235
Sperry Products, Inc. ....	22
St. Joseph Lead Co. ....	8
Standard Alloy Co. ....	135, 144
Standard American Engineering Co. ....	30
Standard Steel Treating Co. ....	137
Stanwood Corporation ....	214
Steel City Testing Machines, Inc. ....	222
Steel Improvement & Forge Co. ....	211
Stuart Oil Co., D. A. ....	176
Sunbeam Stewart Industrial Furnace Div. ....	191
Superior Steel Corp. ....	48A

Superior Tube Co. ....	54
Surface Combustion Corp., Inside Front Cover	
Sylvania Electric Products Co. ....	251

Taylor Sons Co., Charles ....	132
Thermo Electric Co. ....	224
Timken Roller Bearing Co. ....	37
Titanium Alloy Mfg. Division, National Lead Co. ....	225
Titan Metal Manufacturing Co. ....	53
Thompson Products, Inc. ....	227

Union Carbide and Carbon Corp. ....	17, 48B, 113-113, 177
United Engineering and Foundry Co. ....	192A
U. S. Pipe & Foundry Co. ....	40-41
U. S. Steel Co. ....	56-57
United States Testing Co., Inc. ....	139
Upton Electric Furnace Co. ....	134

Vanadium-Alloys Steel Corp. ....	28
Vanadium Corp. of America ....	62
Vincent Steel Process Co. ....	137

Wagner Mfg. Co. ....	143
Wall Colmonoy Corp. ....	194
Westinghouse Electric Corp. ....	161
Wheeler Instruments Co. ....	32B, 55
White Metal Rolling & Stamping Corp. ....	142
Wilson Mechanical Instrument Co. ....	39
Wyckoff Steel Co. ....	234
Wyman-Gordon Co. ....	14

Yoder Co. ....	29
Young Brothers Co. ....	192B
Youngstown Sheet & Tube Co. ....	34

# See... **SPEEDYELECTRIC**

## ALL-ELECTRIC STEAM-JET CLEANERS IN OPERATION BOOTH B228 NATIONAL METAL EXPOSITION

### NEW JC-25

Dry steam at 200 p.s.i. Economical, only 25 amps at 550 v. Compact and portable, 48" long, 18" wide—rubber-tired swivel casters. Finger-tip control of steam and detergent. Fast—beats 5 men using hand methods. All electric... no flames, fumes or fire hazards!

### NEW JC-75

Steam to 200 p.s.i. . . . finger-tip control . . . COMBINING high temperature dry steam blast, atomized concentrated solvents and the terrific impact of a hot water jet at pressures to 400 p.s.i. . . . ALL-ELECTRIC—no flames, fumes or fire hazards!

**Livingstone Engineering Company**  
Manufacturers of **STEAM-JET** Steam Generator  
100 Grove Street • Worcester 5, Mass.



## Rebuild Worn Parts by Metallizing

Save time, money and critical parts by Metallizing with new Mogulelectric Gun. Adds metal to metal with fine atomization for perfect bond. Simplified, easy to use, engineered to give trouble-free service.

Also ideal for spraying corrosion-resistant metal coatings and for production work.

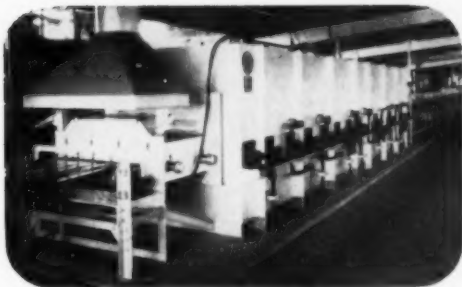
If you already have metallizing equipment, why not consider a trade-in now for the new Mogulelectric Gun.

Write for new booklet containing complete information on equipment as well as production and maintenance applications.

**METALLIZING COMPANY OF AMERICA**  
3520 W. Carroll Avenue • Chicago 24, Ill.



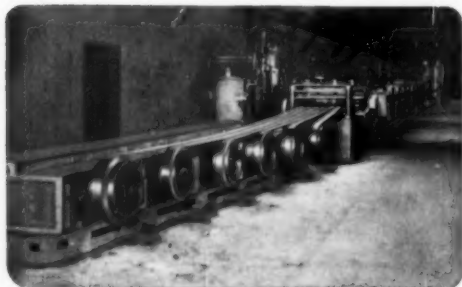
Steel strip in single or multiple strands up to a total width of 54" may be bright annealed or normalized, continuously, in this EF gas fired radiant tube installation. Capacity 7500 lbs. per hour.



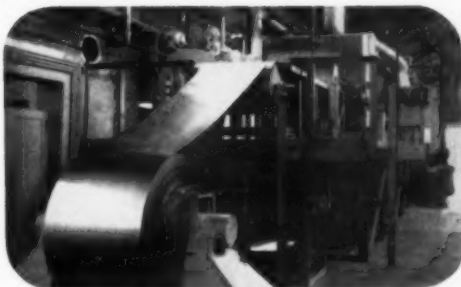
An EF electrically heated special atmosphere installation bright annealing six parallel strands of cold rolled steel strip, continuously. Handles single or multiple strands up to a total width of 30"

## CONTINUOUS **EF** INSTALLATIONS

**For Bright Annealing, Normalizing, Galvanizing  
and Other Continuous Processing of Strip**



Another EF gas fired radiant tube, continuous furnace for bright annealing or normalizing cold rolled strip steel. Has preheater or burn-off chamber and handles 2000 lbs. strip per hour.



An EF special atmosphere furnace with flame preheating burn-off or oxidizing section, and controlled heating and cooling zones for producing various surface conditions on strip steel.

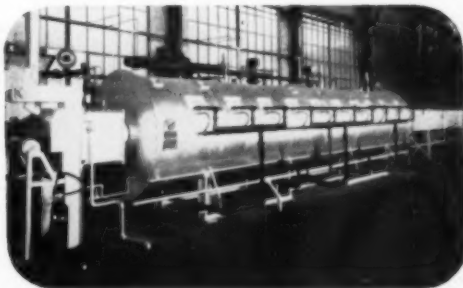
*Designed and Built by*

**The Electric Furnace Co., Salem, Ohio**

**Gas Fired, Oil Fired and Electric Furnaces — For Any Process, Product or Production**

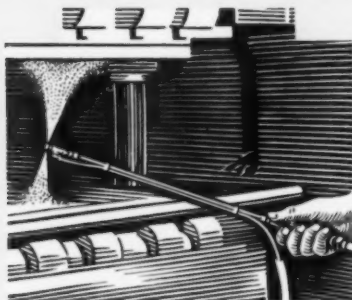


This EF combination fuel fired and electrically heated strip processing unit provides extreme flexibility in heating, soaking and controlled cooling cycles for treating various grades of strip.



Stainless steel strip is bright or process annealed continuously in this EF gas fired special atmosphere tube muffle type furnace. It also handles other strip requiring lower temperatures.

**NO SMOKE... NO FUMES**  
**in Hot Forging with...**  
**"dag" Colloidal Graphite**



**"Dag"** colloidal graphite dispersed in water eliminates smoke and fumes in hot forging operations . . . greatly improves working conditions. The lubricating properties of colloidal graphite are superior, too, giving increased production . . . reduced die wear . . . better finish . . . and usually a saving in steel stock.

The uses of **"dag"** colloidal graphite for hot forging operations are fully explained in a specially prepared article entitled "Forging Die Lubrication". Copies are available without obligation. Write today to Acheson Colloids Corporation, Port Huron, Michigan, for Bulletin #750-10K.



**Acheson Colloids Corporation**

Port Huron, Mich.

... also Acheson Colloids Limited, London, England